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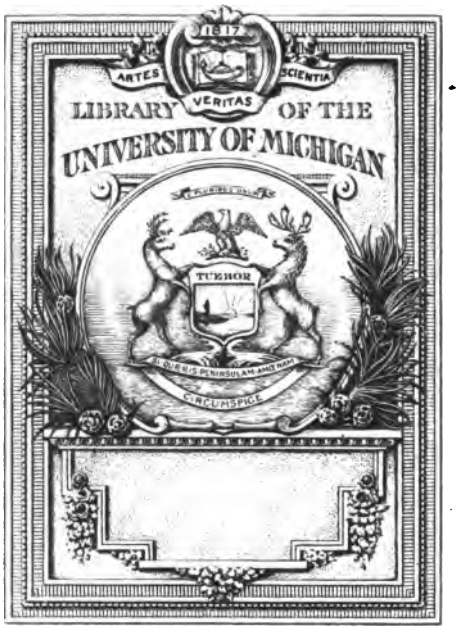
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REPORT

OF THE

PLANT PATHOLOGIST

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR 1912

UNION HILL, N. J.
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TABLE OF CONTENTS.

Table of Contents

	PAGES.
XV. REPORT OF THE PLANT PATHOLOGIST	509–527
Diseases of—	
Alfalfa	515
Apple	516
Arbor Vitæ	517
Ash	517
Asparagus	517
Bean	517
Beet	518
Blackberry	518
Boxwood	518
Cabbage	518
Catalpa	520
Cedar	519
Celery	519
Cherry	519
Chestnut	519
Chestnut Bark Disease	513
Corn	519
Currant	520
Dahlia	520
Dewberry	520
Diseases of the Year	515
Eggplant	521
Flowering Crab	520
Gladiolus	521
Gooseberry	521
Grape	521
Hollyhock	521
Horsechestnut	521
Ivy	516
Kerria japonica	522
Lilac	522
Maple	522
Mulberry	522
Muskmelon	522
Mustard	522
Nursery Inspection	509–512
Oak	523
Oats	523
Onion	523

XV. REPORT OF THE PLANT PATHOLOGIST—*Continued.* PAGES.

Orchard 513
Peach 523
Pear 524
Phlox 525
Pine 524
Plane tree 526
Plum 524
Potato 525
Quince 525
Raspberry 525
Rose 525
Strawberry 526
Sunflower 526
Sweet Potato 526
Tomato 526
Turnip 527
Wheat 527
Inspection of Home Nursery 512
Inspection of Foreign Nursery Stock..... 513
Organization of the Department of Plant Pathology.. 509
Publication of the Department of Plant Pathology.... 514
Investigation 515

REPORT OF THE PLANT PATHOLOGIST.

No.	Name.	Town.	County.
13.	Alvah L. Reynolds	Madison	Morris.
14.	Geo. H. Peterson	Fair Lawn	Bergen.
15.	John Moore	Little Silver	Monmouth.
16.	Charles Momm	Irvington	Essex.
17.	John McCleary	Sewell	Gloucester.
18.	William Rose	Red Bank	Monmouth.
19.	Jas. Ambacher	West End	Monmouth.
20.	J. D. Brown	Allenhurst	Monmouth.
21.	James Clinton	Morris Plains	Morris.
22.	W. G. Eisele	West End	Monmouth.
23.	W. H. Forristel	Plainfield	Union.
24.	V. J. Humbrecht	West Windsor	Mercer.
25.	Amon Heights Nursery Co.	Merchantville	Camden.
26.	F. E. Beugelaar	Rutherford	Bergen.
27.	Frank Breck	Vineland	Cumberland.
28.	Michael N. Borgo	Vineland	Cumberland.
29.	Mrs. N. P. Creely	Burlington	Burlington.
30.	John Casazza	East Vineland	Cumberland.
31.	Peter Henderson & Co.	Jersey City	Hudson.
32.	W. A. Manda, Inc.	South Orange	Essex.
33.	Vineland Grape Juice Co.	Vineland	Cumberland.
34.	Geo. Macaltione	Woodstown	Salem.
35.	Wm. L. Ewing	Fishing Creek	Cape May.
36.	K. E. de Waal Malefyt	Ridgewood	Bergen.
37.	J. J. Phelps	Hackensack	Bergen.
38.	K. Herman Stoye	Eatontown	Monmouth.
39.	Mrs. E. P. McColgan	Red Bank	Monmouth.
40.	Arthur J. Collins	Moorestown	Burlington.
41.	J. M. Ralston	Allenhurst	Monmouth.
42.	M. O'Hagen	Asbury Park	Monmouth.
43.	Wm. O'Hagen	Asbury Park	Monmouth.
44.	Mrs. W. S. Hertzog	Morris Plains	Morris.
45.	Carlman Ribsam	Trenton	Mercer.
46.	North Jersey Nurseries	Millburn	Essex.
52.	Jos. H. Black Son & Co.	Hightstown	Mercer.
53.	Charles Black	Hightstown	Mercer.
57.	Bassett & Weller	Hammonton	Atlantic.
58.	R. D. Cole	Bridgeton	Cumberland.
59.	Geo. W. Bassett	Hammonton	Atlantic.
60.	C. B. Horner & Sons	Mount Holly	Burlington.
61.	J. T. Garrison & Sons	Woodruff	Cumberland.
62.	Ellsworth Pedrick	Woodruff	Cumberland.
63.	Hiram T. Jones	Elizabeth	Union.
65.	S. T. Pullen	Englishtown	Monmouth.
66.	Chas. A. Baird	Freehold	Monmouth.
67.	George A. Shultz	Jamesburg	Middlesex.
68.	Chas. H. Totty	Madison	Morris.
69.	Samuel Brant	Madison	Morris.
70.	Chas. A. Bennett	Newtown	Mercer.
71.	Albert Nelson	Allentown	Monmouth.
72.	W. H. Polhemus	Robbinsville	Mercer.
77.	Henry E. Burr	South Orange	Essex.

No.	Name.	Town.	County.
78.	J. T. Randolph	Rutherford	Bergen.
79.	John Bennett	Atlantic Highlands	Monmouth.
80.	J. E. Kuhns	Cliffwood	Monmouth.
81.	Wm. W. Lukens	Princeton	Mercer.
82.	The Chas. C. Owens Co.	Orange	Essex.
83.	Garfield Williamson	Ridgefield	Bergen.
86.	Frank Lenz	Irvington	Essex.
85.	J. T. Lovett	Little Silver	Monmouth.
89.	Edwin Allen & Son	New Brunswick	Middlesex.
90.	Samuel C. DeCou	Moorestown	Burlington.
91.	Max Rumprecht	Fort Lee	Bergen.
93.	Bound Brook Nurseries	Bound Brook	Somerset.
94.	T. C. Kevitt	Athenia	Passaic.
95.	James Apgar	Fairmount	Hunterdon.
96.	Williard Apgar	Fairmount	Hunterdon.
97.	Mrs. E. B. Conover	Fairmount	Hunterdon.
98.	Mansfield Eick	Bissell	Hunterdon.
99.	J. H. Lindsley	White House	Hunterdon.
100.	W. S. Perry	Vail	Warren.
101.	J. C. Williams	Montclair	Essex.
103.	Stanton B. Cole	Bridgeton	Cumberland.
104.	John W. Henry	Lebanon	Hunterdon.
105.	Samuel H. Wilson	Allerton	Hunterdon.
106.	W. S. Pullen & Co.	Cranbury	Middlesex.
107.	P. V. Drake	Hopewell	Mercer.
108.	Francis Pettit	Mount Rose	Mercer.
109.	Wilfred Everingham	Woodsville	Mercer.
110.	Charles Bird	Arlington	Hudson.
111.	John Fleming	Parker	Morris.
112.	J. Kaiser Davis	Chester	Morris.
113.	Mathias Fleming	Parker	Morris.
115.	Cicero Higgins	Ringoes	Hunterdon.
116.	H. C. Steinhoff	West Norwood	Bergen.
117.	Wm. C. Evans	Sewell	Gloucester.
121.	J. Monroe Mattison	Englewood	Bergen.
122.	David V. Higgins	Ringoes	Hunterdon.
123.	James H. Vliet	Gladstone	Somerset.
124.	J. D. Lindsley	Mendham	Morris.
125.	Luther A. Apgar	High Bridge	Hunterdon.
126.	Wm. Tricker	Arlington	Hudson.

Most of the nurseries which were handling pine trees were inspected in the spring or early summer by the writer to determine their freedom from the blister rust (*Peridermium strobi* Klebahn). During July and August nearly all the nurseries were inspected by Mr. Dickerson, and a few also by the writer. The few remaining nurseries, which were devoted to the growing of strawberries, were inspected by Mr. H. B. Weiss, of the Department of Entomology.

The nurserymen very generally expressed a willingness to cooperate with the department in its work, some of them cancelling orders for European white pine stock, others voluntarily destroying white pine stock which they suspected, while several of them have sent diseased plants and asked for advice.

The following diseases were the most common and most important found in the nurseries:

Apple, pear and quince—Canker caused by fire blight (*Bacillus amylovorus* (Burr) De Toni) and black rot (*Sphaeropsis malorum* Pk.) which also caused a leaf spot. Rust, which also occurred on flowering crab. Crown gall on but very few trees.

Blackberries, dewberries and raspberries—Anthracnose (*Gloeosporium Venetum* Speg) quite common but not severe. Double blossom (*Fusarium Rubi* Winter) was quite common, especially on dewberries. Crown gall (*Pseudomonas Tumefaciens* Smith and Townsend) was quite common on red raspberries.

Boxwood—A leaf and stem disease (*Volutella Boxi* (Cola) Berh.) on stock imported from Holland. Destroyed by consignee.

Chestnut—Very little chestnut is handled by the New Jersey nurserymen, and every nursery handling such stock was found to be infected with the bark disease (*Diaporthe parasitica* Murrill). All of the diseased stock, and in some cases the entire stock, was destroyed.

Currants—Anthracnose (*Pseudopeziza ribis* Kleb) and cane blight (*Nectria cinnabarina* (Tode) Fr.) were found in a few nurseries and some stock destroyed.

Hollyhock—Rust (*Puccinia malvacearum* Mont.).

Peach—Yellows and little peach are two diseases which are said to be distributed through the nursery, but are very difficult to detect in young trees. A number of trees which we suspected of being diseased were destroyed upon our recommendation. However, it appears to the writer that some method other than inspection must be devised for the control of these diseases. It also appears that the most feasible method will be to supply the nurserymen with bud wood from our own state orchards.

Other diseases of minor importance will be mentioned in the list of plant diseases reported from various sources.

ORCHARD INSPECTION.

During the summer a number of orchards were also inspected upon the request of the owners, and advice given for the control of diseases.

INSPECTION OF IMPORTED STOCK.

The passage of a quarantine law by the last session of Congress and a subsequent quarantining of a considerable part of Europe for protection against the introduction of the wart disease of the potato and the blister rust of the white pine has been greatly to our advantage. It was impossible to inspect cargoes of potatoes in such a manner as to make the work efficient. Although the great bulk of such shipments was intended for food, it was impossible to prevent ignorant and irresponsible individuals from selling or using them for seed. Therefore, the importation of potatoes from countries where the disease is known to exist was a continual menace to the potato growing industry of the entire country.

The character of the blister rust of the white pine is such as to make its detection impossible until it has reached the eruptive stage. Since the imported stock might not show the disease at the time of importation, it was possible for it to be distributed on the market and to develop the disease one, two or three years later. Therefore, the inspection for this disease was more or less uncertain. There is a considerable quantity of European pines in the New Jersey nurseries, which must be kept under observation until ready to put on the market.

The inspection of stock from other states is a problem to which we are giving considerable attention. There are a great many shipments to many points. The shipments to the nurserymen can usually be reached, but the small shipments to individuals are not so easily managed.

CHESTNUT BARK DISEASE.

The very destructive disease which threatens to destroy our chestnut timber has spread to practically every part of the State where there is any chestnut growth. The total loss to the country

at large will no doubt exceed $25,000,000. During the year the writer attended two conferences for the consideration of this very important disease. One called by Governor Tener of Pennsylvania met at Harrisburg, February 20th and 21st, and was attended by more than 200 delegates and visitors, representing fourteen states, the District of Columbia and Canada. The report of this conference has been published by the Commission for the Investigation and Control of the Chestnut Tree Blight Disease in Pennsylvania.

The second conference was called by Dr. Haven Metcalf of the United States Bureau of Plant Industry and held in Washington, D. C., August 29th and 30th, for the purpose of considering the best methods of investigating the chestnut bark disease in accordance with a Federal appropriation of $80,000 for this purpose. One of the results of this conference was the subdividing of the investigation into ten heads, and the writer was appointed to supervise one of these lines of work. The Federal authorities will appoint a man who will be stationed at New Brunswick to assist in this work.

PUBLICATIONS.

The character of certain diseases which were likely to be introduced into the State at any time and certain outbreaks which did occur made it necessary to issue the following series of press bulletins:

No. 1. Chestnut Bark Disease (January).
No. 2. Canker or Wart Disease of the Potato (January).
No. 3. Blister Rust of the White Pine (April).
No. 4. Crown Gall and Hairy Root (May).
No. 5. Peach Yellows, Little Peach and Peach Rosette (July).
No. 6. Potato Failures (August).

These bulletins were sent to the press throughout the State and also to the local granges. In addition to these bulletins the writer also prepared a paper on "Diseases of Shade and Forest Trees" which was published by the Forest Park Reservation Commission of New Jersey in connection with a work by State Forester Alfred Gaskill on "The Planting and Care of Shade Trees."

It appears to the writer to be advisable to continue the publication of the press bulletins from time to time, treating the more

important epidemics, and also to publish a series of circulars treating the most common and most important diseases occurring in the State.

INVESTIGATIONS.

The work of the year has indicated that the most valuable work of the department will be the investigation of diseases already present in the State. Therefore, we have projected the following lines of work:

1. The Chestnut Bark disease in co-operation with the United States Bureau of Plant Industry, which has already been referred to.
2. A study of peach yellows and little peach for the purpose of determining the causes, if possible, and the factors which are conducive to the control of the disease.
3. A study of the diseases of sweet potatoes both in the field and in the storehouse.
4. A study of the apple rots with special attention to a dry spot rot which is very common on the Jonathan in storage.
5. A study of the storage rot of the Dahlias.

DISEASES OF THE YEAR.

The following is a list of diseases which have been reported or collected by members of the staff during the year. More than half of these diseases were sent in by farmers with inquiries as to their character and methods of control. In some cases there were a great many inquiries concerning a disease.

ALFALFA (*Medicago sativa* L.).

LEAF SPOT. *Pseudopeziza medicaginis* (Lib.) Sacc. Very common and widely distributed throughout the State. Very severe in late summer and fall. No practical method of control.

IVY (*Ampelopsis veitchii*).

*Leaf Spot. *Phyllosticta ampelopsidis* E. & M. Very common, especially near the ground.

APPLE (*Pyrus malus* L.).

*Crown Gall and Hairy Root. *Pseudomonas tumefaciens* E. S. & T. This disease is widely distributed throughout the State, but is most severe in the raspberry growing districts. According to the United States government reports it occurs on at least twenty-four species of plants in fourteen families. It attacks the apple, pear, peach, plum, cherry, bush berries and roses. It is most severe on the red raspberries, reducing the size and vigor of the plants and causing a decreased crop. Peaches affected with this disease will not bear as well as healthy trees. The spongy tissues of the galls is also a favorite place for the work of the peach tree borer, and the combined work of these two pests is the cause of heavy losses to the peach industry. The disease is less severe on the apple, and there is a great difference of opinion as to the amount of loss due to this cause. It is very evident that trees affected with the disease will frequently grow and have all the appearance of perfect health, but such trees will not as a rule produce as well as healthy trees. The planting of trees affected with this disease is to be discouraged.

*Black Rot. *Sphaeropsis malorum* Pk. This disease is quite common in both orchard and nursery, and in some cases has proved to be especially severe. The disease attacks leaves, stem and fruit. The most severe case coming to our attention this year was in an orchard in which a row of bearing Delaware winter trees was practically ruined by branch and trunk cankers.

*Ripe Rot. *Glomerella rufomaculans* (Berk) S. and von S. This disease is widely distributed and was destructive in unsprayed orchards.

Pink Rot. *Cephalothecium roseum* Cda. This rot is not serious except in storage.

Brown Rot. *Sclerotinia fructigena* (Pers.) Schret. On fruit of trees near peach and plum trees. Of no importance.

SPOT ROT. *Alternaria* sp. This rot, which caused numerous small dry specks on fruit in storage, was found on several varieties but was most severe on the Jonathan. It is the subject for investigations which we are now conducting.

*FIRE BLIGHT. *Bacillus amylovorus* (Burr) De Toni. This very common and well known disease has not been especially severe this year.

*SCAB. *Venturia pomi* (Fr.) Wint. Very abundant and very severe. In many cases the regular spraying treatments did not control it.

BLOTCH. *Phyllosticta solitaria* E. & E. Common.

FLY SPECK. *Leptothyrium pomi* (Mont. & Fr.) Sacc. Common.

LEAF SPOT. *Coryneum foliicolum* Fckl. One record.

*RUST. *Gymnosporangium macropus* Lk. Common but not serious.

ARBOR VITÆ (*Thuja occidentalis* L.).

*DIE BACK. Apparently due to *Pestolozzia* sp. Common and severe in some cases.

ASH (*Fraxinus americana* L.).

DIE BACK. Cause undetermined. Several complaints.

ASPARAGUS (*Asparagus* sp.).

RUST. *Puccinia asparagi* De C. Not serious.

BEAN (*Phaseolus* sp.).

ANTHRACNOSE. *Colletotrichum lindemuthianum* (S. & M.) B. & C. Not serious.

LEAF SPOT. *Phyllosticta* sp. A severe outbreak of this disease in the Jewish settlements in the vicinity of Vineland practically ruined the crop of pole lima beans for a large number

of farmers. The disease appeared as a spotting which practically ruined the foliage and occurred to some extent on the stems and pods. It was almost entirely restricted to a territory which had just previously been swept by a severe wind storm, which no doubt caused numerous wounds affording a ready entrance for the fungus. It was not severe on the bush lima beans. An outbreak of this disease was reported by Dr. Halsted in 1891.

BEET (*Beta vulgaris* L.).

LEAF SPOT. *Cercospora beticola* Sacc. Common.

BLACKBERRY (*Rubus* sp.).

*ANTHRACNOSE. *Gloeosporium venetum* Speg. Of no great importance this year. Growers should set clean plants, and nurserymen should spray their stock with Bordeaux mixture.

*LEAF SPOT. *Septoria rubi* West. Common.

RUST. *Gymnoconia interstitialis* (Schlecht) Lagh. Common. Diseased plants should be dug and burned.

BOXWOOD (*Buxus* sp.).

*LEAF AND STEM DISEASE. *Volutella boxi* (Cda.) Berk. Found in one nursery on stock imported from Holland. The entire stock was destroyed.

CABBAGE (*Brassica oleracea* L.).

CLUB ROOT. *Plasmodiophora brassicæ* Wor. This disease occurs locally throughout the State. It can be controlled by rotation of crops and by free liming of the soil.

BLACK ROT. *Pseudomonas campestris* (Pammel) Erw. Smith. This disease occurs locally throughout the State. It can be controlled by rotation of the crops and by treating the seed for twenty minutes in formalin (1 part formalin to 200 parts water).

DAMPING OFF. *Fusarium* sp. Occurs in seed beds and cold frames.

CEDAR (*Juniperus virginiana* L.).

RUST. *Gymnosporangium macropus* Lk. Common throughout the State.

CHERRY (*Prunus* sp.)

BROWN ROT. *Sclerotinia fructigena* (Bers) Schroet. Common. See peach.

*LEAF SPOT. *Cylindrosporium padi* Karst. This disease was very common, and we received a great many inquiries concerning it. Spraying with commercial lime sulfur just as the buds are beginning to swell will be of great benefit. Additional spraying with self-boiled lime-sulfur about thirty days after blooming and again just after gathering the crop will practically control the disease.

CELERY (*Apium graveoleus* L.).

LEAF BLIGHT. *Cercospora apii* Fr. Common, especially in the southern part of the State. All diseased plants should be rejected and the young plants in the beds should be sprayed with Bordeaux mixture. The Bordeaux treatment may be repeated in the field about once in every two weeks.

CHESTNUT (*Castanea dentata* (Marsh) Borkh.).

*BLIGHT. *Diaporthe parasitica* Murrill. This disease is quite common throughout the State, and there is practically no hope of checking its ravages on the native growths.

CORN (*Zea mays* L.).

SMUT. *Ustilago Zeæ* (Beckm.) Ung. Common and very severe in some localities.

RUST. *Puccinia sorghii* Schw. On late planting.

FLOWERING CRAB (*Crataegus* sp.).

*Rust. *Gymnosporangium* sp. In a few nurseries.

CURRANT (*Ribes* sp.).

*Cane Blight. *Nectria cinnabarina* (Tode) Fr. Occurred in the northern part of the State. The diseased parts should be cut out and burned.

Anthracnose. *Pseudopeziza ribes* Kleb. Common and quite severe in the north part of the State. Plants should be sprayed with Bordeaux mixture every three or four weeks throughout the season except when the fruit is approaching maturity.

CATALPA (*Catalpa bignonioides* Walt.).

*Leaf Spot. *Cercospora catalpæ* Wint. Common.

DAHLIA (*Dahlia* sp.).

Rot. Cause not definitely determined. Reported from the southern part of the State.

DEWBERRY (*Rubus* sp.).

*Anthracnose.
*Leaf Spot.
Rust.
} See Blackberry.

*Double Blossom. *Fusarium rubi* Wint. Common, especially in the southern part of the State. This disease can be readily controlled by removing the diseased buds as soon as the disease appears in the spring.

EGGPLANT (*Solanum melongena* L.).

WILT. *Bacterial.* Not severe this year.

GLADIOLUS (*Gladiolus* sp.).

BULB ROT. Cause undetermined.

GOOSEBERRY (*Ribes grossularia* L.).

*LEAF SPOT. *Septoria ribis* Desm. Common. This disease can be controlled by spraying with Bordeaux mixture every three or four weeks throughout the growing season except during the maturity of the fruit.

GRAPE (*Vitis* sp.).

NECROSIS. *Fusicoccum viticolum* Reddick. Reported on grapes grown under glass.

BLACK ROT. *Guignardia bidwellii* (Ell.) V. & R. Common but not severe this year.

DOWNEY MILDEW. *Plasmopara viticola* (B. & C.) D. T. Common but not serious.

HOLLYHOCK (*Althæa rosea* Car.).

*RUST. *Puccinia malvacearum* Mont. Common.

HORSE-CHESTNUT (*Aesculus hippocastanum* L.).

*MILDEW. *Uncinula flexosa* Ph. Rare.

*LEAF SPOT. *Phyllosticta sphaæropsidis* E. & E. Very severe. Can be controlled by spraying with Bordeaux mixture wherever such treatment is practical.

KERRIA JAPONICA.

*Leaf Spot. *Septoria* sp. One report.

LILAC (*Syringia vulgaris* L.).

Powdery Mildew. *Microsphæra alni* (Wallr.) Wint. Common.

MAPLE (*Acer* sp.).

*Tar Spot. *Rhytisma acerinum* (Pers.) Fr. Common.
Slow Dying. Cause undetermined.

MULBERRY (*Morus* sp.).

Die Back. Common. Cause undetermined.

MUSKMELON (*Cucumis melo* L.).

Leaf Mould. *Alternaria brassicæ*. Reported in the northern part of the State.

Wilt. *Necosmospora vasinfecta* (Atk.) Smith. Reported in northern part of the State.

Downey Mildew. *Plasmopara cubensis* (B. & C.) Humphrey. Common. Can be readily controlled by frequent sprayings with Bordeaux mixture.

MUSTARD (*Brassica* sp.).

White Rust. *Cystopus candidus* (Pers.) Lev. Common. Not found on cultivated crops.

OAK (*Quercus alba* L.).

BARK DISEASE. Cause undetermined. Not serious.

OATS (*Avena sativa* L.).

SMUT. *Ustilago avenæ* (Pers.) Jens. Common.

ONION (*Allium cepa* L.).

BRITTLE. This disease occurred in the vicinity of Mount Holly and caused considerable loss. The cause is undetermined, but it is apparently the same as a disease which appeared in Connecticut in 1905. It prevents the germination of a considerable quantity of seeds or destroys the young plants soon after germination or causes a dwarfing of many that survive. It occurs in restricted areas over the fields.

PEACH (*Prunus persica* (B. & H.).

BROWN ROT. *Sclerotinia fructigena* (Pers.) Schroet. This well known disease is very common and was very abundant and destructive on trees that were not properly sprayed.

*CROWN GALL. *Pseudomonas tumefaciens* E. S. & T. This disease is quite common and widely distributed and is quite severe in some cases.

*LEAF CURL. *Exoascus deformans* (Berk.) Fuckel. Very abundant and very destructive on trees that are not properly protected by spraying.

*YELLOWS. Cause unknown. This disease is very common and very destructive. In many cases it is undoubtedly distributed through the nurseries, and inspection of the nurseries will result in the detection of only a small percentage of the diseased trees. It appears to the writer that the only satisfactory method for the control of this disease will be for the State to furnish our nurserymen with guaranteed healthy bud wood from the state farms.

*Little Peach. Cause unknown. This disease is more abundant and more destructive than the yellows, and the writer makes the same recommendation as for yellows.

*Shot Hole. *Coryneum beijernickii* Oud. Common and abundant on neglected trees.

*Powdery Mildew. On crowded nursery stock only.

Scab. *Cladosporium carpophilum* Thum. Common and very abundant in orchards that were not sprayed.

PEAR (*Pyrus communis* L.).

*Fire Blight. *Bacillus amylovorus* (Burr.) De Toni. Common, but not severe this year.

*Leaf Blight. *Entomosporium maculatum* Lev.—Reported from a few localities.

*Scab. *Venturia pyrina* Aderh. Common, especially on neglected trees.

Leaf Spot. *Septoria pyricola* Desm. Common.

PINE (*Pinus taeda* L.).

Rust. *Peridermium pini* Chev. One report. On seedling.

PINE (*P. strobus* L.).

Rust. *P. strobi* Kleb. Seedlings were found with scars which indicated the presence of the fungus at an earlier date.

PLUM (*Prunus* sp.).

*Black Knot. *Plowrightia morbosa* (Schn.) Sacc. Common.

Brown Rot. See peach.

Little Plum. Cause unknown. Reported.

POTATO (*Solanum tuberosum* L.).

STEM BLIGHT. *Fusarium oxysporium* Schl. This disease was the cause of considerable loss in various parts of the State. It can be controlled by rejecting all potatoes which show black streaks when cut and by the proper rotation of crops.

ROOT AND STEM DISEASE. *Corticium vagum* B. & C. var. *solani* Burt. One report.

EARLY BLIGHT. *Macrosporium solani* E. & M. Common.

LATE BLIGHT. *Phytophthora infestans* (Mont.) De Bary. One report.

SCAB. *Oospora scabies* Thaxter. This disease was very abundant and very injurious throughout the State. It can be readily controlled by rotation of crops and by soaking the seed tubers for two hours in formalin. One pound formalin in thirty gallons of water.

PHLOX.

POWDERY MILDEW. *Erysiphe communis* (Walh) Schl.

QUINCE (*Cydonia vulgaris* Pers.).

*BLACK ROT. *Sphæropsis malorum* Pk. Common.

*FRUIT SPOT. *Cylindrosporium pomi* Brooks. One report.

*RUST. *Gymnosporangium globosum* Farl. Common.

RASPBERRY (*Rubus* sp.).

*CROWN GALL. See peach.

CANE BLIGHT. *Coniothyrium Fuckelii* Sacc. One report.

LEAF SPOT. *Septoria rubi.* See Blackberry.

ROSE (*Rosa* sp.).

*BLACK LEAF SPOT. *Actinonema rosæ* (Lib.) Fr. Common in greenhouses.

*MILDEW. *Peronospora sparsa* Berk.

STRAWBERRY (*Fragaria* sp.).

*Leaf Spot. *Mycosphærella fragariæ* (Tul.) Lindau. Common.

Winter Injury. Reported.

SUNFLOWER (*Helianthus annuus* L.).

Rust. *Puccinia helianthii* Schw. On College Farm.

Damping Off. *Fusarium* sp. Under glass.

SWEET POTATO (*Ipomœa batatus* Lam.).

Black Rot. *Sphæronema fimbriatum* (E. & H.) Sacc. More destructive than usual throughout the sweet potato growing districts of the State.

Wet Rot. *Rhizopus nigricans* Ehr. Common. Attacks potatoes in storage but can be controlled by proper ventilation.

Stem Rot or Yellow Rot. *Nectria ipomoeae* Hals. More destructive than usual this year.

PLANE TREE (*Platanus occidentalis* L.).

Blight. *Gnomonia veneta* (Sacc. & Speg.) Kleb. Common. Less severe on the Oriental species.

TOMATO (*Lycopersicon esculentum* Mill.)

Anthracnose. *Colletotrichum phomoides* (Sacc.) Chester. A few reports.

Fruit Rot. *Macrosporium solani* E. & M. Common.

Stem Blight. *Fusarium lycopersici* Sacc. Common, but not severe this year.

Filiform Leaf. Cause undetermined. Two reports.

Blossom End Rot. Cause questionable. Common.

Leaf Spot. *Septoria lycopersici* Speg. Common.

TURNIP (*Brassica campestris* L.).

CLUB ROOT. *Plasmodiophora brassicæ* Wor. Reported.
SPLITTING OR CRACKING. Reported.

WHEAT (*Triticum* sp.).

RUST. *Puccinia graminis* Pers. Common.
SMUT. *Ustilago tritici* (Pers.) Jen. Common.
SMUT. *Tilletia fœtens* (B. & C.) Trel. Reported.

NOTE.—The diseases marked with a * were found in nurseries.

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REPORT

OF THE

PLANT PATHOLOGIST

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR 1913

TRENTON, N. J.
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Table of Contents.

	PAGES.
XVIII. Report of the Plant Pathologist,	791–817
Organization,	793
Climatic Conditions,	793
Nursery Inspection,	794
Inspection of Interstate and Foreign Shipments,	795
Epidemics,	796
Investigations,	796
Publications,	797
New Jersey Potato Association,	798
Diseases of—	
Alfalfa,	799
Ampelopsis,	799
Apple,	799
Artichoke,	801
Asparagus,	801
Aster,	801
Bean,	801
Beet,	801
Blackberry,	801
Cabbage, Cauliflower and Kohlrabi,	802
Carnation,	802
Catalpa,	802
Cedar,	802
Celery,	802
Cherry,	802
Chestnut,	803
Clover, Crimson,	803
Clover, Red,	803
Corn,	803
Cranberry,	803
Cucumber,	803
Dewberry,	804
Dogwood,	804
Eggplant,	804
Elder,	804
Grape,	804
Hemlock,	804
Hollyhock,	804
Horse-Chestnut,	804
Huckleberry,	805

XVIII. Report of the Plant Pathologist—*Continued.* PAGES.

Diseases of—

Juniper, ... 805
Kalmia latifolia, ... 805
Lilac, ... 805
Maple, ... 805
Muskmelon, ... 805
Oak, ... 805
Oats, ... 806
Pansy, ... 806
Pea, ... 806
Peach, ... 806
Pear, ... 807
Pepper, ... 807
Pine, ... 807
Plum, ... 807
Poplar, ... 808
Potato, ... 808
Quince, ... 809
Raspberry, ... 809
Rose, ... 810
Strawberry, ... 810
Sweet Potato, ... 810
Sycamore, ... 810
Trees, ... 811
Tomatoes, ... 811
Violet, ... 811
Wheat, ... 811

Report on Potato Field Tests at Elmer, ... 812–817

REPORT OF THE PLANT PATHOLOGIST.

Report of the Plant Pathologist.

MELVILLE T. COOK, PH.D.

ORGANIZATION.

The department has been strengthened by the addition of Mr. Guy West Wilson, A. M., M. Sc., Special Agent of the U. S. Department of Agriculture, who will co-operate with the department in the study of the chestnut bark disease, and by Mr. H. Clay Lint, B. S., who has been appointed to the fellowship in plant pathology in Rutgers College. This fellowship was established by the Union Sulphur Company for the study of potato scab. In accordance with such provision, Mr. Lint will devote the greater part of his time to the diseases of the potato. Mr. C. A. Schwarze will continue with us as Assistant State Plant Pathologist and Mr. G. W. Martin as Assistant Plant Pathologist in the Experiment Station. Mr. Edgar L. Dickerson was employed as Special Assistant State Plant Pathologist during July and August to assist with the nursery inspections.

CLIMATIC CONDITIONS.

The weather conditions for 1913 have been extremely unfavorable for most crops. A warm period in March, followed by two weeks of wet cold weather, caused great damage to fruit and potato crops. This was followed by a very dry summer season, which caused heavy losses is most crops. The drought also caused severe injury to a great many shade and ornamental trees.

CO-OPERATION.

Experiments with potatoes were conducted on the farm of Mr. Spencer W. Perrine, of Cranbury; on the farm of Mr. J. Harry Kandle, of Elmer, in co-operation with the Department of

Entomology; also a number of experiments in various parts of the State in co-operation with the Extension Department. The experiments at Cranbury and Elmer were under the immediate direction of Mr. Martin of this department, while those in co-operation with the Extension Department were under the immediate direction of Mr. John H. Voorhees.

Experiments on orchard treatments were conducted in the orchards of Mr. Albert T. Repp, of Glassboro, in co-operation with the Department of Entomology and under the immediate direction of Mr. Weiss of that department.

A few small experiments with sweet potatoes were conducted on the farm of Mr. Meyer Goldman, at Norma, Mr. R. H. Weatherby and Mr. Willard B. Kille, at Swedesboro.

NURSERY INSPECTION.

All the nurseries of the State have been inspected in accordance with chapter 54, Laws of 1911. They were exceptionally free from fungus and bacterial diseases. White pines affected with blister rust were found in two small nurseries and the entire white pine stock destroyed. Blights and cankers were frequently found on left-over fruit stock that had not been properly cared for, and the attention of the owners called to its condition.

Our studies of fruit diseases in both orchard and nursery emphasize the impossibility of absolutely controlling peach yellows and little peach by inspection. Therefore, we co-operated with the Department of Horticulture in offering the nurserymen a limited number of peach buds from the State Orchard. These buds were taken from bearing trees that had been under observation for several years, and which we have every reason to believe to be free from the above diseases. Seventeen nurserymen availed themselves of this offer, but one application was made too late to be filled. More than 30,000 buds were distributed as indicated in the following table:

		Elberta.	Carman.	Belle of Georgia.	Stump.	Fox Seedling.	Francis.	Edgemont.	Arp Beauty.	Miss Lola.	Champion.	Late Crawford.	Early Crawford.	Stevens Rare Ripe.	
Willard Apgar, ...	Califon, ...	X	X	X						X	X		X		X
Jos. H. Black, Son & Co.,	Hightstown, .	X	X	X	X	X			X		X	X	X	X	X
Bound Brook Nurseries,.	Bound Brook,.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Samuel Brant, ...	Madison, ...	X	X	X	X	X	X	X	X	X	X			X	X
R. D. Cole, ...	Bridgeton, ...	X	X	X	X	X					X	X	X	X	X
C. A. Conover & Son,...	Lebanon, ...	X	X	X	X	X		X	X		X	X	X	X	X
J. K. Davis, ...	Chester, ...	X	X	X	X	X					X	X		X	X
F. & F., ...	Springfield, ..	X	X	X	X	X				X	X	X	X	X	X
John Fleming, ...	Califon, ...		X		X				X						X
Matthias Fleming, ...	Califon, ...	X	X	X	X	X					X	X			X
Cy. Gousset,*	Allendale, ...	X			X							X	X		X
J. D. Lindsley, ...	Mendham, ...	X	X	X	X						X				X
J. T. Lovett, ...	Little Silver,.								X	X					X
John McCleary & Son,..	Sewell, ...	X	X				X				X				X
W. S. Perry, ...	Delaware, ...	X	X	X	X	X	X	X		X	X	X	X	X	X
Howard N. Philhower,..	Mountainville,	X	X	X	X	X	X	X	X	X	X	X			X
Samuel H. Wilson, ...	Lebanon, ...	X	X	X	X	X					X	X			X

* Not a nurseryman.

Although the number of buds was necessarily limited as compared with the demand, they will serve as a basis from which the nurserymen can grow buds for future use. We expect to continue this offer next year and no doubt many more of our nurserymen will avail themselves of the opportunity to secure buds, true to name and as free from peach yellows and little peach as is possible to determine with our present knowledge of these diseases.

INSPECTION OF INTER-STATE AND FOREIGN SHIPMENTS.

The shipment of stock into the State was so large that it was impossible to inspect any considerable amount of it. However, the work was carried forward as thoroughly as funds and circumstances permitted. The only new disease was the silver scurf (*Spondylocladium atrovirens* Harz.), an European disease of the potato which came in on northern seed. This disease came in on so many shipments and at so many points that it was impossible to do anything to prevent it without seriously hampering the potato interests of the State. Furthermore, it is very doubtful if it will prove a serious disease for our growers.

Some fruit stock was condemned on account of crown gall and the attention of the consignors called to the State law.

EPIDEMICS.

Several diseases were so severe as to assume the proportions of epidemics. (1) The potato crop suffered greatly from a combination of weather conditions and diseases. The most important of these diseases were the southern bacterial wilt, scab, blackleg, Fusarium wilt and scurf (see page 808). (2) The apple scab was far more severe than usual and reduced the market value of great quantities of apples (see page 800). (3) Fire blight was exceptionally severe on apples, pears and quinces (see page 800).

INVESTIGATIONS.

The following lines of investigations are under way:

(1) The potato diseases were so severe that it was necessary for us to give a great deal of attention to their control. Experimental work was carried on in different parts of the State in co-operation with the Department of Entomology and the Extension Department. These experiments were under the immediate direction of Mr. G. W. Martin. The potato growing industry is of such great importance and the diseases are so severe that this line of work will demand a great deal of attention in the future. This work will be greatly facilitated by the Fellowship in Plant Pathology which has been established by the Union Sulphur Company. Mr. H. Clay Lint has been appointed fellow and will give the major part of his attention to the diseases of the potato.

(2) The orchard interests of the State are also demanding more and more attention. During the past season we gave some time to the study of the orchard diseases, but it has been impossible to do the work satisfactorily without a larger working force. Some experimental work was carried on for the control of apple scab in co-operation with the Department of Entomology and this work will require far more attention another year. The following orchard experiments are in progress: (a) A study of

the Jonathan apple spot rot to determine the cause and methods of control; these experiments are conducted on the College Farm under the immediate supervision of this Department. (b) A study of peach yellows in co-operation with the Department of Horticulture. This work is carried on at the College Farm, at Vineland and at High Bridge. (c) A series of experiments to determine the possibility of controlling crown gall in the nurseries. These experiments are conducted in co-operation with one of the leading nurserymen of the State.

(3) The chestnut blight or bark disease continues to be the scourge of our forests and the natural growth of chestnut timber is gradually disappearing. We are making a special study of this disease in co-operation with the United States Bureau of Plant Industry. Mr. Guy West Wilson, Special Agent, is in direct charge of this work.

(4) A few preliminary experiments on the diseases of sweet potatoes were conducted in the southern part of the State. Before any very satisfactory work on the diseases of this important crop can be done it will be necessary to have the control of a piece of land in the southern part of the State and an assistant to take charge of the work.

(5) Some preliminary experiments were also conducted on the diseases of cranberries. We hope to continue this work during 1914.

PUBLICATIONS.

The following publications have been issued during the year:

1. Press Bulletin No. 7 by the State Board of Agriculture on "Winter Treatment of Peaches and Pears."

2. A Circular No. 18 by the Extension Department on "Potato Diseases and Methods of Control."

3. A short paper on "The Jonathan Spot Rot," by Mel. T. Cook and G. W. Martin in Phytopathology (3; 119, 120).

4. A short paper on "A Botrytis Disease of Dahlias," by Mel. T. Cook and C. A. Schwarze in Phytopathology (3; 171-173).

The following publications will be issued in the near future:

Potato Diseases in New Jersey.
Crown Gall and Hairy Root.
Diseases of Nursery Stock.
Treatment of Seed Wheat for Smut.

NEW JERSEY POTATO ASSOCIATION.

At the August Farmers' Day meeting the potato growers of the State held a special session and organized the New Jersey Potato Association for the purpose of co-operating with the National Potato Association of America. The object of the National Association as stated in its constitution is as follows:

"The object of this Association shall be to bring together for mutual co-operation and co-ordination of effort all agencies interested in the production, transportation, distribution and utilization of potatoes, and the promotion of the potato industry in all its phases.

"To create a general interest in better seed, true to name and free from disease.

"To stimulate the development of new and improved varieties, possessing greater adaptability to special soil or climatic conditions; a higher starch content, greater productiveness, or marked immunity of vine or tuber to disease.

"To provide for the proper description of varieties and the establishment of a bureau of registration and nomenclature for new and worthy introductions.

"To encourage a system of pure seed certification through field inspection of the growing crop.

"To assist in determining varietal adaptation through uniform varietal tests in all parts of the country.

"To encourage the co-ordination of potato investigations by the United States Department of Agriculture and the State Experiment Stations.

"To raise the standard of market requirements for table stock through more careful grading and packing, and better eating quality.

"To stimulate the investigation of methods for the profitable utilization of surplus and cull potatoes.

"To encourage measures designed to safeguard our American industry against the introduction of disease and insect pests.

"To establish a more effective system of distribution and marketing.

"To encourage the formation of co-operative growing and selling exchanges.

"To promote an interest in potato contests and exhibitions.

"To establish and maintain a system of crop forecasting for the mutual benefit of its members.

"To collect and disseminate the best available information relating to both the practical and scientific phases involved in increased yields, coupled with a lessened cost."

NEEDS.

The greatest need of the department is a larger force of men to take up the many problems which are demanding attention.

Most Common Diseases of the Year.

Alfalfa.

LEAF SPOT (*Pseudopeziza medicaginis* (Lib.) Sacc.). This disease has been about the same as in past years. There were several inquiries concerning it, but no evidence that it has been more destructive than in previous years.

Ampelopsis.

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

DIE BACH (*Cladosporium* Sp.). This disease was quite serious on the *A. tricuspidata* on buildings, especially where the plants were growing under crowded condition. The organism is very generally present on the old fruits, where it apparently grows as a saprophyte, occasionally becoming parasitic. Its severity this year was probably due to the dry weather.

Apple.

JONATHAN SPOT (cause undetermined). This disease continues from year to year with about equal severity. It is one of our problems for investigation (see page 796). Fig. 1.

BLOSSOM END ROT (*Alternaria* Sp.). This disease continues to cause a great deal of trouble with many varieties, and is one of the problems demanding more time than we have been able to give to it. Fig. 2.

ANTHRACNOSE or BITTER ROT (*Glomerella rufomaculans* (Berk.) Spaulding & Von Schenck). This disease does not appear to be so severe this year as last year. This may be due to the dry season.

BLACK ROT (*Sphæropsis malorum* Pk.). Not so severe as usual. In this State it is most severe on Red Astrachan, Star, Lawver and Smokehouse. Figs. 3 and 4.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). This well-known disease was especially severe, and we received more inquiries concerning it than any other disease of the orchard. The disease is usually more severe during a very dry season.

BLOTCH (*Phyllosticta solitaria* E. & E.). This disease has been very severe on some varieties, especially Smith's Cider. Fig. 5.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith and Townsend). This disease continues quite common, but the fruit-growers are coming to realize the importance of growing trees that are as nearly perfect and as healthy as it is possible to make them by selection and culture. A number of our growers refused to accept nursery stock affected with this disease. The disease was found on shipments from twelve nurseries located outside the State, and on shipments from three nurseries in the State. When we take into consideration the large number of nurserymen who are handling fruit stock and the great loss incurred in destroying this stock, we must acknowledge that the number who have permitted such stock to escape is quite small.

SOOTY BLOTCH (*Phyllachora pomigena* (Schw.) Sacc.). Common. Fig. 6.

BROWN ROT (*Sclerotinia fructigena* (Per) Schroet). This very common disease of the peach and plum is not considered severe on the apple, but this season we have had one case in which it was quite destructive in the apple orchard. We find it quite generally where apple and peach trees growing together ripen at the same time.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphæropsis malorum* Pk.). Common, but not so severe as usual.

RUST (*Gymnosporangium macropus* Lk.). Very little to be found.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This was by far the worst fruit disease of the season, and was very severe in orchards, in which it was not previously known as a disease of importance. It was more severe in the southern than in the northern part of the State, and occurred on practically all varieties, including the crab.

WINTER INJURY. A great many trees died from a crown rot, dating back to the severe winter of 1911–12.

Artichoke.

MILDEW (*Erysiphe cichoracearum*). One report.

Asparagus.

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

Aster.

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. It was much more severe on outdoor than on indoor plants.

Bean.

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav). This disease was very common throughout the State, but more severe in the southern than in the northern part. A wet season would have made the bean crop a complete failure.

LEAF SPOT (*Phyllosticta* Sp.). This disease was quite common on the Lima beans, but not so severe as last year. Fig. 7.

"DAMPING OFF." A few reports, but not general.

Beet.

LEAF BLIGHT (*Cercospora beticola* (Sacc.). Quite common.

Blackberry.

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common and destructive in many places. We had more inquiries concerning it than usual.

LEAF SPOT (*Septoria rubi* West). Common.

RUST (*Gymnoconia peckiana* (Howe) Tranz.). Common and the subject of many inquiries.

RUST ON STEM (*Uredo muelleri Schroet*). One report.

Cabbage, Cauliflower and Kohlrabi.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.) This disease was reported from many localities.

LEAF MOLD (*Macrosporium brassicæ* Berk.). One report.

Carnation.

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

YELLOWS (?). Serious on some varieties.

Catalpa.

LEAF SPOT (*Macrosporium catalpæ* Ell. & Mart.). Common.

LEAF SPOT (*Phyllosticta catalpæ*. Ell. & Mart.). Common.

Cedar.

RUST (*Gymnosporangium macropus* Lk.). (*Gymnosporangium germinale* (Schu.) Kern.). Reported but of little importance.

Celery.

EARLY LEAF BLIGHT. (*Cercospora apii* Fr.). Reported from several places.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Reported.

ROOT ROT. One report. Apparently due to fertilizers.

STEM AND ROOT ROT (*Sclerotinia sp.*). One report early in the spring.

Cherry.

BROWN ROT (*Sclerotinia fructigena* (Pers.) Schroet). Common.

LEAF SPOT (*Cylindrosporium padi* Karst.). Common, but not so much complaint as in 1912.

SHOT HOLE (*Cercospora circumscissa* Sacc.). Common but not serious in many cases.

Chestnut.

BARK DISEASE (*Endothia parasitica* (Mur..) Ander.). Common throughout the State.

Crimson Clover.

CROWN ROT (*Sclerotinia libertiana* Fuckel). Widely distributed throughout the southern part of the State. For several years there have been increasing complaints of the dying out of the crimson clover in the spring. Examination of specimens from several fields proved this to be due to a *sclerotium* disease, which has also been reported from States farther south. The character of the disease is such that the only treatment is crop rotation. Many of our farmers will find it advantageous to use winter vetch for a winter cover crop.

Red Clover.

RUST (*Uromyces trifolii* (Hedw.) Lev.). Occurs throughout the State.

Corn.

SMUT (*Ustilago zeæ* (Beckm.) Ung.). This very common and very widely distributed disease is not often serious except on sweet corn. However, this year our attention has been called to a locality in which it is exceptionally destructive. Fig. 8.

WILT (*Pseudomonas stewarti* Erw. Smith). This disease was reported from several localities in the early part of the season, and was the cause of considerable loss among growers of early sweet corn.

Cranberry.

SCALD (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the State, and the cause of considerable loss where the bogs were not well sprayed.

Cucumber.

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed and the cause of considerable loss.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common.

Dewberry.

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand picking of the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds. Fig. 9.

ANTHRACNOSE (*Glœosporium venetum* Speg.). See Blackberry.

LEAF SPOT (*Septoria rubi* West). Common.

Dogwood (Cornus siberica).

LEAF SPOT (*Phoma* sp.). One report.

Eggplant.

LEAF BLIGHT (*Phyllosticta hortorum* Speg.). Very common and in some cases destructive.

Elder.

RUST (*Æcidium sambuci* S.). Common.

Grape.

BLACK ROT (*Guignardia bidwellii* (Ell.) Viala & Ravaz). Common and very destructive in some vineyards in the southern part of the State.

NECROSIS (*Fusicoccum viticolum* Reddick). One report from Burlington county.

Hemlock.

PESTALOZZIA sp. On dead twigs.

Hollyhock.

RUST (*Puccinia malvacearum* Mont.). Very common and the subject of many inquiries.

Horse-Chestnut.

LEAF BLOTCH (*Phyllosticta paviæ* Desm.). Less severe than usual.

Huckleberry.

GALL (*Exobasidium vaccinii* (Fckl.) Wor.). Common in the vicinity of cranberry bogs.

Juniper.

RUST OR CEDAR APPLE. See Apple.

Kalmia Latifolia.

Pestalozzia kalmicola E. T. E. Common.
Phyllosticta kalmicola Cke. Common.

Lilac.

MILDEW (*Microsphæra alni* (Wallr.) Wint.). Abundant throughout the State.

LEAF SPOT (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple.

BARK DISEASE (*Nectria coccinea* or *N. cinnabarina*). The *Tubercularia* stage of *Nectria* was found on Norway maples in two localities in the State and in one place was doing considerable damage. Fig. 10.

TAR SPOT (*Rhytisma acerinum* (P.) Fr.). Common.

Muskmelon.

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Common and destructive in some cases.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common but not severe.

MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common but not severe.

Oak.

DIE BACK (*Cytospora* sp.). This disease was quite severe on the chestnut oaks in the vicinity of Red Bank. The disease is somewhat similar to the chestnut bark disease, but not likely to prove so severe.

Oats.

SMUT (*Ustilago avenæ* (Pers.) Jens.). Common. Fig. 11.
SPOT OR BLIGHT (*Colletotrichum cereale* Mann). Common.
RUST (*Puccinia graminis* Pers.). Common.
RUST (*Puccinia coronata* Cda.). Common.

Pansy.

LEAF SPOT (*Colletotrichum violæ-tricolaris* R. E. Smith). One report from nursery.

Pea.

STEM AND ROOT ROT. Quite common and destructive in the vicinity of Riverton. Cause undetermined.

Peach.

BROWN ROT (*Sclerotinia fructigina* (Pers.) Schroet.). Common throughout the State but less severe on the fruit than usual. Perfect stage collected at Highbridge, N. J., by C. A. Schwarze, April 24th, 1913.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith and Townsend). Common. See Apple.

LEAF CURL (*Exoascus deformans* (Berk) Fuckel). Abundant where the orchards were not sprayed and more or less common where the spraying was not properly done. Wherever the trees were thoroughly sprayed with lime-sulphur before the growth started there was practically no curl. However, a few warm days caused considerable growth before some growers completed their spraying and in fact in some cases stopped the work. In these cases the amount of curl depended on the time of spraying; the later the treatment the more severe the disease. Fig. 12.

SCAB (*Cladosporium carpophilum* Thüm.). The severity of this very common disease varied largely with the thoroughness of the spraying. Fig. 13.

YELLOWS AND LITTLE PEACH. Prevalent. (See page 794.)

Pear.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Common. See Apple.

LEAF BLIGHT (*Entomosporium maculatum* Lev.). Abundant. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

LEAF SPOT (*Coryneum longistipitatum* (Berl.) Bres.). One report.

SCAB (*Venturia pyrina* Aderh.). Abundant.

Pepper.

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in the fall.

ROT (*Macrosporium* sp.). Common on fruits and also found on seeds. May have been secondary.

Pine.

ROOT DISEASE. This disease was due to a fungus ordinarily occurring in a mycorhizal relation but in the case of the white pine causing the trees to die. It occurred in two nurseries and caused considerable loss. Acting upon our recommendations the nurserymen removed a number of the trees to new ground and planted them under less crowded conditions. This treatment gave excellent results.

BLISTER RUST (*Peridermium strobi* Klebalm). A few white pine trees affected with this disease were found in two nurseries. They were destroyed.

RUST (*Peridermium piriforme* Pk). On seedling loblolly pine sent in by State Forester Alfred Gaskill. The seedlings were grown in South Jersey and the plantation will be kept under careful observation to determine the severity of the disease.

Lophodermium brachysporum Rostr. On leaves of Pinus Excelsa.

Plum.

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thüm.). Common throughout the State.

BROWN ROT (*Sclerotinia fructigena* (Pers.) Schroet). Common throughout the State. See peach.

Poplar.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). An exceptionally severe case of crown gall was found in a planting of Bolleana poplars. These trees had been planted on filled-in land which we have every reason to believe was new and free from disease. The galls were abundant on roots, trunks and branches several feet above ground. Many of the trees were almost dead and all showed the effect of the disease.

LEAF SPOT (*Marsonia populi* (Lib.) Sacc.). Abundant.

Potato.

BACTERIAL ROT (*Bacillus vulgaris* Hauser). This disease appeared as a rotting of the tubers and was the cause of many complaints from various parts of the State. Some of the seed from Maine contained numerous rotten potatoes and the plantings from these lots suffered a greater loss than plantings from seed that were not so affected. The cold wet weather the latter part of March made this rot exceptionally severe.

SOUTHERN BACTERIAL WILT (*Bacillus solanacearum* E. F. Smith). This disease, also known as "sleeping sickness," attacks potatoes, tomatoes, egg plants, peppers and tobacco. It was especially severe this year and was the most important cause of our shortage of crop. It is always most severe in very dry seasons and on dry soils. It has been known in the State on tomatoes since 1903. (See page 796.)

BLACK LEG (*Bacillus phytophthorus* Appel). This well-known disease was quite severe throughout the southern half of the State and was second in importance as the cause of our shortage.

SCAB (*Oospora scabies* Thaxt.). This disease was fully as severe as in past years except in those localities where the growers used the formaldehyde treatment for their seed. This treatment was so successful that many more may be expected to use it next year.

RUSSET SCAB (Cause undetermined). A peculiar russetting was common in many parts of the State. It is one of the subjects for further study.

SCURF (*Corticium vagum* B. & C. var. *solani* Burt.). This very widely distributed disease was much more severe this year than usual. It was especially severe on the late crops and was one of the very important factors in reducing the yield.

SILVER SCURF (*Spondylocladium atrovirens* Harz.). This newly introduced European disease was very common on the Maine seed. Its seriousness is a problem for the future.

DRY ROT AND WILT (*Fusarium oxysporum* Schlecht). This well-known disease was about equally severe as in 1912 and is one of the diseases with which our growers must contend.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). This disease was of very little importance this year.

LATE BLIGHT (*Phytophthora infestan* De By). This disease was of very little importance in our fields. However, some of the Maine seed was thrown away because of the affected tubers.

ARSENICAL POISONING was reported from a few localities. It was always due to careless treatment.

TIP BURN. Although our season was exceptionally warm and dry, there was very little complaint from this well-known climatic trouble.

Quince.

BLACK ROT (*Sphæropsis malorum Pk.*). Very abundant and very severe. See Apple.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Abundant and severe. See Apple.

RUST (*Rostellia aurentiana* Peck.) Reported from several localities.

Raspberry.

ANTHRACNOSE (*Glœosporium venetum* Speg.) Abundant.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. See Apple.

LEAF SPOT (*Septoria rubi* West). Abundant.

Rose.

CROWN GALL (*Pseudomonas. tumefaciens* Erw. Smith & Townsend). Frequent.

ANTHRACNOSE (*Gloeosporium rosæ* Hals.). Common, but not serious.

LEAF BLOTCH (*Actinonema rosæ* (Lib.) Fr.). Common and very severe in the greenhouses.

POWDERY MILDEW (*Sphærotheca pannosa* (Wallr.) Lev.). Common and very severe in the greenhouse.

LEAF SPOT (*Phyllosticta rosicola* Massal). Abundant and frequently confused with black spot.

Strawberry.

LEAF SPOT (*Mycosphærella fragariæ* (Tul.) Lindau). Common.

WINTER INJURY. Reported from several localities.

Sweet Potato.

BLACK ROT (*Sphæronema fimbriatum* (E. & H.) Saac.). Abundant, but not so severe as in 1912.

WET ROT (*Rhizopus nigricans* Ehr.). Common in storage, but readily controlled by ventilation.

STEM ROT OR YELLOW ROT (*Fusarium batatatis*). Common, but not so destructive as in 1912.

ROT (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.

CHARCOAL ROT (*Sclerotium bataticola* Taub.) Frequent.

ROT (*Trichoderma Koenigii* Ould.). Common.

ROT (*Fusarium batatatis* Taub.). Common. May have been secondary.

ROT (*Melanospora globosa* Berl.). Common. May have been secondary.

ROT (*Penicillium* sp.). Common. May have been secondary.

Sycamore.

ANTHRACNOSE (*Gnomonia veneta* (Sacc. & Speg.) Kleb.). Common.

Trees.

DROUTH. Our attention was called to a great many cases in which foliage on trees was turning brown, dying, and in some cases falling. This was very evidently due to the small amount of rainfall.

WINTER INJURY. Our attention was also called to a great many fruit and shade trees which were suffering from injury incurred in the severe winter of 1911–12.

GAS. Our attention was also called to many trees which were dying from gas injury.

Tomatoes.

BACTERIAL WILT (*Bacillus solanacearum* Erw. Smith). Reported, but not so severe as on potatoes.

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). A few reports.

FRUIT ROT (*Macrosporium solani* E. & M.). Common.

STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common, but not severe.

FILIFORM LEAF (Cause undetermined). Abundant on College Farm. Also from one other point in the State.

BLOSSOM END ROT (Cause questionable). Common.

LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and severe.

Violet.

LEAF SPOT (*Alternaria violæ* G. & D.). One report from a nursery.

Wheat.

RUST (*Puccinia coronate* Cda.). Common. (*Puccinia graminis* Pers.). Common. (*Puccinia rubigo-vera* (DeC.). Wint.). Common

SMUT (*Tilletia foetens* (B. & C.) Trel.). Frequent. (*Tilletia tritici* (Bei.) Wint.). Abundant.

SMUT (*Ustilago tritici* (Pers.) Jens.). Common.

MOLD (*Cladosporium herbarum* (Pers.) Lk.). Abundant in places.

Report on Potato Field Tests at Elmer.

(This series of experiments was conducted in co-operation with the Department of Entomology and under the direct supervision of Mr. G. W. Martin, Assistant Plant Pathologist.)

The field tests at Elmer were for the purpose of determining whether finely pulverized sulfur and powdered arsenate of lead can, with proper combination and application, be depended upon to protect potato foliage from insect injury and fungous disease, and whether the use of these substances on a commercial scale is practicable. Four powdered preparations were used, as follows: Sulfur 3 parts, arsenate of lead 1 part; sulfur 2 parts, arsenate of lead 2 parts; sulfur 1 part, arsenate of lead 3 parts; arsenate of lead only, as a check plot. In order to compare the results secured from the dust with those from the standard wet spray, a plot was treated with Bordeaux mixture and Paris green, using a 5–5–50 solution with 1½ lbs. of Paris green to each 50 gallons. Furthermore, since comparatively few growers in southern New Jersey use the home-made Bordeaux, it was thought advisable to add a plot sprayed with Pyrox, which has been a standard commercial Bordeaux in this section. In addition to this, the makers of two other commercial Bordeaux preparations agreed to furnish a sufficient supply to treat one plot with each, and accordingly plots treated with "Kil-Tone"* and "Electro" Bordo-Lead†

For the dusting work a Johnson potato duster was loaned by the Dust Sprayer Manufacturing Company, of Kansas City, Mo. In this machine a fan operated by traction power drives the powder into a boom made of heavy iron pipe, from which it is fed into six fan-shaped delivery tubes, thus treating six rows at once. Some slight trouble in operation was experienced at first,

* Sold by Charles F. Dare & Son, Bridgeton, N. J.
† Made by Vreeland Chemical Company, Little Falls, N. J.

mixture were added, thus making four wet plots.

due to the fact that the feed was uneven. This was caused by the slipping of the belt that operated the fan, and a dressing applied to the belt quickly remedied the defect. Unfortunately, this cause was not recognized until after the first three treatments had been applied, and as a result the amounts of dust used were somewhat different than they should have been, as will be explained later.

The Field Force Pump Company, of Elmira, N. Y., furnished a New Watson traction sprayer fitted with a 12-nozzle boom for use with the liquid preparations. This arrangement permits four rows to be treated at a time, using three nozzles to a row; one directly above the row, and one at each side. The two latter are adjustable and are usually directed slightly upward. The pressure maintained was from 50 to 60 lbs., which was perhaps a trifle too low to secure a sufficiently fine spray.

The tests were on the farm of Mr. J. Harry Kandle, about three miles west of Elmer. The field was a sandy loam, and had been in hay for two or three years before being planted to early potatoes in the spring of 1911. After these were harvested, clover was sown, and the clover sod plowed under early in the spring of 1913. The land was plowed 8 to 9 inches deep and thoroughly harrowed, and the potatoes were planted April 3d and 4th. A 4–8–10 fertilizer was applied at the time of planting at the rate of 2,200 lbs. to the acre. The seed was of the Irish Cobbler variety, practically the only early potato grown in South Jersey, and was what is known as second crop New Jersey seed, grown from Maine seed stock in the summer and fall of 1912 and planted after the main crop had been harvested. All seed was treated with formaldehyde gas before planting. Eight plots were used, each plot containing eighteen rows 699 feet long and 2 feet 8 inches apart, or .77 of an acre. They were arranged as follows:

Plot 1—Bordeaux and Paris green.
Plot 2—Kil-Tone, 9 lbs. to 50 gals.
Plot 3—Pyrox, 9 lbs. to 50 gals.
Plot 4—Electro Bordo-Lead, 9 lbs. to 50 gals.
Plot 5—Sulfur, 3 parts; arsenate of lead, 1 part.
Plot 6—Sulfur, 2 parts; arsenate of lead, 2 parts.
Plot 7—Sulfur, 1 part, arsenate of lead, 3 parts.
Plot 8—Arsenate of lead only (check plot).

While the seed was all of the same variety, that used in the first six plots and four rows of Plot 7 was grown from stock secured from one Maine grower, while that used in the remaining rows of Plot 7 and Plot 8 was grown from stock secured from a different Maine grower. There seemed to be a slight advantage in favor of the latter seed as evidenced by the comparative vigor of the vines.

After planting, the weather became cold and wet and generally unfavorable conditions prevailed until the last of the month, when from April 28th to May 7th ten days of warm and mostly clear weather brought the sprouts well above ground. When they were well up a week of cold weather followed, in two or three nights of which frost occurred. The vines were quite seriously cut back, the injury being most severe on Plot 1 and slightly less severe on each succeeding plot. After the middle of the month more favorable weather helped to repair the damage and by May 27th the vines were large enough to warrant their being sprayed. The aim was to keep the vines covered with the spray or dust mixture during the growing season. It cannot be claimed that this was accomplished, as even to approximate it would have necessitated applying the treatments every four or five days. The vines were, however, thoroughly covered at each treatment given, and at the time of the later treatments there was nearly always some material left on the older leaves from the preceding treatment. The Bordeaux mixture stayed on the vines much better than any of the other preparations, while Pyrox was second best in this respect. All of the plots were treated four times, Plots 1 to 4 on May 27th, June 11th, June 20th and July 5th, and Plots 5 to 8 on May 31st, June 14th, June 20th and July 1st. An inspection made on May 6th showed both the Colorado beetle and the flea beetle to be abundant on the young plants. On June 5th, after the first treatment, both were fairly abundant on the wet plots and relatively few in number on the dry plots. By June 14th, after the wet plots had received two treatments and the dry plots but one, conditions were reversed and there were scarcely any Colorado beetles on the former while they were fairly numerous on the latter, and the flea beetles, while not

numerous, were more plentiful on the dry plots than on the wet. The fleas were at that time more numerous on Plot 8 than on any of the other plots. After this, the Colorado beetles practically disappeared from the plots, but the flea beetles increased rapidly and after July 1st they were very numerous on all the plots and did much damage to the vines. The Bordeaux seemed to have absolutely no effect in driving them away. If anything, they were more plentiful at this time on Plot 1 and the other wet plots than on the dry plots. Early blight was observed on July 1st on Plots 1, 2, 5, 6, 7 and 8, being most noticeable on Plots 6 and 8, although very slight in every instance. By July 10th it had become rather common in all the plots and in addition there was a considerable amount of tip burn and spray injury on Plots 1 to 4, probably due to the fact that the spraying of July 5th was under a hot sun. By this time the vines were beginning to mature and any further treatments were out of the question as no machine could go through the rows without seriously injuring them. By July 14th the plots began to die. The dust-treated plots died first, closely followed by Plots 2, 4 and 3 in the order given. An inspection made July 22d showed Plots 5, 6, 7 and 8 wholly dead, Plots 2 and 4 practically so, and Plot 3 with a slight amount of green in the stems. Plot 1 was still quite green. This gave the plot sprayed with Bordeaux mixture an opportunity to grow about ten days longer than any of the other plots, but as the ground was very dry little or no growth occurred. In this connection one interesting feature is worthy of note. As there were eighteen rows in a plot and the sprayer treated four at a time, it necessarily followed that the fifteenth and sixteenth rows in every wet plot received a double spraying. The inspection of July 22d showed these two rows in Plot 1 to be noticeably greener and larger than the others on the same plot. There was a similar, but slighter, difference in the corresponding rows on Plot 3. The potatoes were dug the first two weeks of August and gave the following yields:

Plot.	*Material.*	*Primes.*	*Seconds.*	*Total.*
1	Bordeaux mixture, ...	337	52	389
2	Bordeaux Kil-Tone, ...	325	44	369
3	Pyrox, ...	364	40	404
4	Electro Bordo-Lead, ...	343	41	384
5	Sulfur, 3; Lead, 1, ...	372	41	413
6	Sulfur, 2; Lead, 2, ...	361	46	407
7	Sulfur, 1; Lead, 3, ...	349	48	397
8	Arsenate of Lead only, ...	380	40	420

This is equivalent to a yield of 545 baskets or 340 bushels to the acre on the best plot, while the entire series of 8 plots averaged 517 baskets, or 323 bushels, to the acre.

Judged by the yield alone, the results seem to be in favor of the dusting, but the several factors already referred to, namely, the damage by frost, which was more severe on the end of the field in which Plot 1 was situated, than on the other end; the more vigorous strain on Plots 7 and 8, and finally, the dry weather when Plot 1—the only plot that showed a decided response to treatment by an increase in vigor and length of growing season —was maturing, must all be taken into consideration.

There was a marked difference in the amount of material used in the dry dusting plots, the arsenate of lead feeding out much more slowly than the lead and sulfur mixtures. The following table gives the cost of the treatments:

Plot.	Material Used Per Treatment.	Time.	Cost of Labor and Team.	Cost of Material Per Lb.	Cost of Each Treatment.	Cost of Four Treatments.
1	7½ lbs Lime, ... 7½ lbs. Bluestone, ... 2¼ lbs. Paris Green, ..	1 hr.,	$0 42	$0 01 08 19	$1 10	$4 40
2	13½ lbs. Kil-Tone, ...	¾ hr.,	32	12	1 94	7 76
3	13½ lbs. Pyrox, ...	¾ hr.,	32	13	2 08	8 32
4	13½ lbs. Bordo-Lead, ...	¾ hr.,	32	12	1 94	7 76
5	24 lbs. Micro, 1-3, ...	¼ hr.,	09	10¾	2 67	10 68
6	22 lbs. Micro, 2-2, ...	¼ hr.,	09	14½	3 28	13 12
7	20 lbs. Micro, 1-3, ...	¼ hr.,	09	21	4 29	17 16
8	12 lbs. Ars. Lead, ...	¼ hr.,	09	22	2 73	10 92

The amounts of material used are estimated, as it was of course impossible to put just enough in the machines to exactly cover one plot at each treatment, and what was left over was in every case used in the same field on potatoes not included in the

plots. The labor on the wet plots was a man with a team at 35 cents an hour, and a boy at 7 cents. The dust plots required only the man and team.

The most striking results shown in the table are, first, the relative economy of Bordeaux mixture, and second, the short time required to apply the powders. The amount of dust used could probably be reduced considerably without impairing the efficiency of the treatment. As previously mentioned, in the three first dustings the blower of the machine was not working well, and the lead was too heavy to be forced out in normal quantities, although the mixtures fed fairly well. After this had been adjusted the machine could be operated with the feed reduced, and had it been working properly all the season the amount of the dust mixtures used would have been less; how much less it is impossible to say. Under such circumstances, the mixture used on Plot 5, 3 parts of sulfur to 1 part arsenate of lead, would be the cheapest of the dusts to use, and would at the same time be entirely effective in controlling the Colorado beetle. The sulfur can be depended upon to cheapen the powder and apparently to improve its physical condition. It must yet be shown that it possesses any pronounced fungicidal value on potato foliage. The ease and quickness with which this mixture can be applied is a decided point in its favor.

In conclusion, the tests have shown that the use of a mixture of pulverized sulfur and arsenate of lead is practicable and efficient in controlling the Colorado beetle. The relative cheapness of the home-made Bordeaux and its effect in prolonging the life of the vines demand further tests to determine the influence of this spray on the yield. Extensive field experiments are called for to devise means for the control of the flea beetle.

Fig. 1.—Jonathan Apple Spot. (Photograph by Prof. M. A. Blake.)

Fig. 2.—Blossom End Rot of Apple. (Photograph by Prof. M. A. Blake.)

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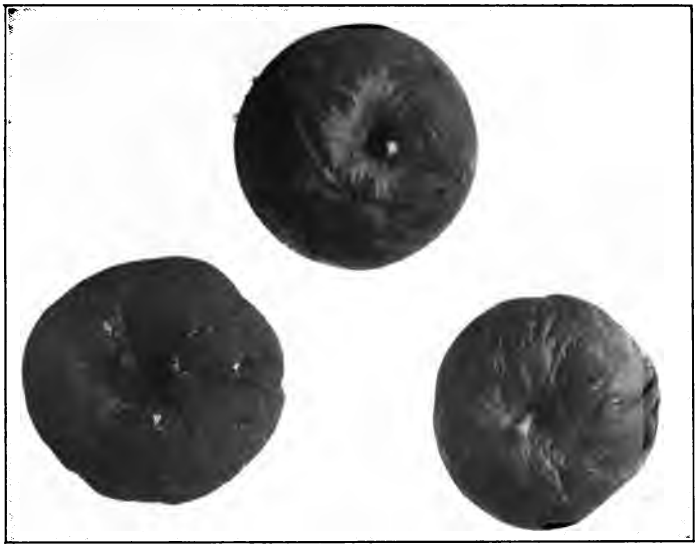

Fig. 3.—Black Rot of Apple. (Photograph by Prof. F. H. Dodge.)

Fig. 4.—Black Rot Canker of Apple. (Photograph by Prof. M. A. Blake.)

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Fig. 5.—Apple Blotch. (Photograph by Prof. M. A. Blake.)

Fig. 6.—Sooty Mold of Apple. (Photograph by Prof. M. A. Blake.)

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Fig. 7.—Leaf Spot of Bean.

Fig. 8.—Corn Smut.

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Fig. 9.—Double Blossom of Dewberry. (Photograph by Mr. G. W. Martin.)

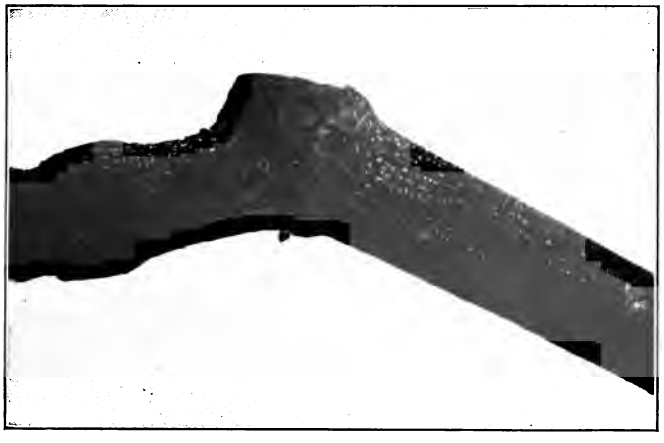

Fig. 10.—Nectria Bark Disease of Norway Maple. (Photograph by Prof. F. H. Dodge.)

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Fig. 11.—Loose Smut of Oats.

Fig. 12.—Peach Leaf Curl. A diseased twig at left; normal at right. (Photograph by Prof. M. A. Blake.)

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Fig. 13.—Peach Scab. Clean fruit at left; diseased at right. (Photograph by Prof. M. A. Blake.)

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REPORT

OF THE

PLANT PATHOLOGIST

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR 1914

PATERSON, N. J.
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Table of Contents.

XVIII. Report of the Plant Pathologist 467-504
Appel, Dr. Otto 470
Apple, Jonathan Spot Rot of Orchard Experiments With 492
Bureau of Plant Industry 467
Collins, J. Franklin 470
Cook, Melville T. 467
500
504
Crown Gall 468
Dickerson, Edgar L. 467
Diseases of Foreign Plants 469
Diseases of—
Alfalfa 470
Ampelopsis 471
Apple 471
Ash 471
Aster 472
Beans 472
Beets 472
Blackberries 472
Boxwood 472
Cabbage 472
Cannas 472
Carnations 472
Cauliflower 472
Cedar 472
Celery 473
Chard 473
Cherry 473
Chestnut 473
Citron 473
Clover 473
Corn 473
Cow Pea 473
Crab 473
Cucumber 473
Currant 473
Dahlia 473
Dewberry 473
Egg Plant 474
Grape 474
Hollyhock 474
Horse Chestnut 474
Larkspur 474
Lilac 474
Maple 474
Oats 474
Okra 474
Peach 474
Pear 475
Pepper 475
Pine 475
Plane Tree 475
Plum 475

XVIII. REPORT OF THE PLANT PATHOLOGIST—*Continued.* PAGES

Poplar 475
Potato 475
Quince 475
Raspberry 476
Rose 476
Snap Dragon 476
Strawberry 476
Sunflower 476
Sweet Potato 476
Tomato 476
Turnip 476
Watermelon 476
Wheat 476
Epidemics of Plant Diseases 466
Gusson, Dr. W. T. 470
Harper, Dr. R. A. 470
Inspection Work 468
Investigations in Plant Pathology 469
Jonathan Spot Rot 500
Kirby, Amos 467
Lint, H. Clay 467
469
477
Little Peach 469
Metcalf, Dr. Haven 470
Manns, Dr. T. F. 470
Martin, G. W. 467
489
500
Maple, Nectria Diseases of 474
Nursery Inspection 467
Needs of Department of Plant Pathology 470
Nectria Parasitic on Maple 504

XVIII. REPORT OF THE PLANT PATHOLOGIST—*Continued.* PAGES

Organization 467
Orton, Dr. W. A. 470
Orchard Experiments 489
Potato, Diseases of— 475
Common Scab 477
Powdery Scab 468
Peach Experiments 489
Peach Buds Distributed 468
Pear Experiments 496
Publications of Department of Plant Pathology 470
Report of Plant Pathologist 467
Scab of Potato
Common 469
Powdery 468
Schwarze, C. A. 467
Stout, Dr. A. B. 470
Sulphur
Used in Apple Experiments 492
Used in Peach Experiments 489
Used in Potato Experiments 477
United States Bureau of Plant Industry 467
Union Sulphur Company 467
499
Visitors to Department of Plant Pathology 470
Walters, G. L. 467
Wilson, G. W. 467

Report of the Plant Pathologist.

MELVILLE T. COOK, PH. D.

ORGANIZATION.

The organization of the departments is practically the same as last year except that the term of Mr. Guy West Wilson, Special Agent of the U. S. Department of Agriculture, expired July first. Mr. G. W. Martin, Experiment Station Assistant in Plant Pathology, has devoted the greater part of his time to sulphur dust treatment of apples and peaches for the control of fungous diseases, and to spraying experiments on Kieffer pears for the control of fungous diseases. Mr. C. A. Schwarze, State Board of Agriculture Assistant in Plant Pathology, gave practically all his time in the fall and spring to the inspection of incoming nursery stock. He has also devoted a great deal of time to the study of the "yellows" of the peach and other plants and to the collection of data for a report on the parasitic fungi of New Jersey.

Mr. Edgar L. Dickerson was employed as Special Assistant State Plant Pathologist for the months of July and August to assist with the nursery inspections. His experience in this work makes his services of the very greatest value. Mr. Amos Kirby was assistant inspector for South Jersey from November 1 to December 15, 1913, and Mr. Geo. L. Walters for the same territory during March and April. Both these men were efficient inspectors. Mr. H. Clay Lint, Union Sulphur Company Fellow for the study of the potato scab, devoted practically all of his time to the study of the influence of sulphur on the potato scab.

Mr. Wilson's work on the chestnut blight was in cooperation with the Forest Pathology Laboratory, Bureau of Plant Industry U. S. Department of Agriculture. Mr. Martin's sulphur dust experiments were in cooperation with the Department of Entomology and the Union Sulphur Company. Mr. Schwarze's work on peach yellows was in cooperation with the Department of Horticulture. Mr. Lint's work on the potato scab was in cooperation with the Union Sulphur Company.

NURSERY INSPECTION.

The nurseries of the State have been inspected in accordance with Chapter 54, Laws of 1911, and in most cases were found to be in exceptionally good condition. There is much greater spirit of cooperation between the nurserymen and the Agricultural Experiment Station than in the past. We have received more inquiries concerning plant diseases than at any time in the past and many nurserymen have called our attention to diseases that would otherwise have escaped notice and have asked for assistance in controlling them.

Following the method introduced last year for the reduction of peach yellows in the State, we again cooperated with the Department of Horticulture in offering bud wood to the nurserymen. Twelve nurserymen availed themselves of this offer and buds were distributed as follows:

Willard Apgar, Fairmount, Elberta, Stump, Waddell, Reeves, and Hiley; Bound Brook, Bound Brook, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Frances, Reeves, Lola, Hiley, and Early Crawford; Samuel Brant, Madison, Greensboro, Waddell, Reeves, Lola, Hiley, Gov. Hogg, and May Flower; R. D. Cole, Bridgeton, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Waddell, Frances, Edgemont, Reeves, Lola, Hiley, Early Crawford, and Steven's Rareripe; J. K. Davis, Chester, Greensboro, Waddell, and Hiley; Mansfield Eick, Bissell, Elberta and Frances; Elizabeth Nurseries, Elizabeth, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Waddell, Frances, Edgemont, Reeves, Lola, Gov. Hogg, and Early Crawford; F. & F., Springfield, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Lola, Hiley, Early Crawford and Steven's Rareripe; John F. Leeds, Waterford Works, Greensboro, Frances, and Arp; K. de Waal Malefyte, Ridgewood, Elberta and Early Crawford; Manalapan Nurseries, Englishtown, Elberta, Carman, Belle of Georgia, Stump, Greensboro, Arp, Reeves, Lola, Hiley, Steven's Rareripe, May Flower, Champion, and Early Wheeler; Samuel H. Wilson, Lebanon, Reeves, Lola, and Mt. Rose.

It will be seen that several of these nurseries also received buds a year ago, but the number of requests was not as large as we expected. However, we were not able to supply the full number of buds called for. Next year it will be necessary to limit the number of buds distributed to each nurseryman. This is a rare opportunity for the nurserymen to secure buds true to name and as free from yellows and little peach as it is possible to determine with our present knowledge of these diseases.

INSPECTION OF INTER-STATE AND FOREIGN SHIPMENTS.

The shipment of stock into this State was so large that it was impossible to inspect any considerable amount of it. However, the work was carried forward in cooperation with the Department of Entomology as thoroughly as circumstances would permit.

The dealers in seed potatoes were not as friendly to inspection of potatoes as the nurserymen are to the inspection of nursery stock. And we regret to say that the Exchanges and Granges did not take as much interest in this work as we expected. The quantity of seed potatoes coming into the State was so large and the amount of our funds so small that it was impossible to inspect more than a very small percentage. POWDERY SCAB (*Spongospora subterranea*) was found on two shipments of potatoes from Maine, but thus far we have not found the disease in the growing crops. The SCURF (*Rhizoctonia*) was found in *great abundance* on many shipments but unfortunately its presence did not disturb many of our dealers or growers. *Such disregard for the presence of this and other diseases is costing our farmers many thousands of dollars annually.*

CROWN GALL (*Pseudomonas tumefaciens* S. & T.) and some other diseases were found on a number of shipments of nursery stock. All such diseased stock was condemned and either destroyed or returned

to the consignors. There is an increasing sentiment against crown gall among our nurserymen and growers. The following parasitic fungi were found on foreign nursery stock:—

Volutella buxi **on boxwood from Holland;** ***Exobasidium azaleæ*** **on Azalea from Belgium;** ***Mycosphærella fagariæ*** **on strawberry from England;** ***Botrytis cinerea*** **on roses from Holland;** ***Colletotrichum kentiæ*** **on Kentia palm from Belgium;** ***Colletotrichum omnivorum*** **on Aspidistea from Belgium;** ***Phyllosticta maculicola*** **on Dracaena terminalis from Europe;** ***Diplodia*** **sp. on orchid from South America;** ***Penicillium*** **sp. on Gladiolus bulbs from Holland;** ***Colletotrichum*** **sp. on Dacaena canes from West Indies;** ***Colletotrichum*** **sp. on Orchids from South America; leaf spot on Rhododendrons from England; twig fungus on English walnut from England; immature fungus on grape canes from England; immature fungus on apple from Holland.**

EPIDEMICS.

The only serious epidemic was the "yellows" of the asters. This disease was prealent in a number of places in the State and was the cause of very heavy losses.

Although, with the exception of the aster "yellows," there were no serious epidemics as compared with those of 1913, yet there were many more inquiries concerning diseases of plants and our correspondence was much heavier than ever before, and we were required to make many more personal visits to points throughout the State than in 1913. If this work continues to increase during the next year as during the past two years, it will require the services of one man to devote all his time and attention to answering inquiries and making personal examinations of crops affected with diseases.

INVESTIGATIONS.

The potato investigations consisted of (1) Mr. Lint's work on the influence of sulphur on potato scab, and (2) Dusting and Spraying experiments in cooperation with the Department of Entomology and the Union Sulphur Company. The field tests were conducted by Mr. A. E. Cameron, of the Department of Entomology, and the results are given in the report of that Department.

The apple orchard investigations were restricted to the use of sulphur for the control of fungus diseases and insects, as compared with the recognized standard treatments which are in general use. The Department has also given some attention to the Jonathan spot rot. The pear orchard investigations were for the purpose of determining the most profitable methods of controlling the leaf and fruit spot fungi. The study of the peach "yellows" and "little peach" will be the subject of a bulletin in the near future. The study of crown gall in the nurseries will be continued. It is impossible to make a report at this time. The investigations on diseases of sweet potatoes and cranberries were discontinued for lack of funds.

PUBLICATIONS.

The following publications have been issued during the year:

(1) Press Bulletin No. 8 by the State Board of Agriculture on "Powdery Scab of the Potato" by Mel. T. Cook.
(2) Circular 33 on "Potato Diseases in New Jersey" by Mel. T. Cook and G. W. Martin.
(3) Circular 34 on "Crown Gall and Hairy Root" by Mel. T. Cook.
(4) Circular 35 on "Some Diseases of Nursery Stock" by Mel. T. Cook.
(5) Circular 36 on "Grain Smuts: Their Causes and Treatments" by Mel. T. Cook.
(6) A short paper on "The Jonathan Spot Rot" by Mel. T. Cook and G. W. Martin in Phytopathology 4: 102–105 (1914).
(7) A short paper on "Cladosporium Disease of Ampelopsis Tricuspidatum" by Mel. T. Cook and Guy West Wilson in Phytopathology 4: 189–190 (1914).
(8) A short paper on "Notes on Economic Fungi" by Mel. T. Cook in Phytopathology 4: 201–203 (1914).
(9) A short paper on "The Southern Bacterial Wilt in New Jersey" by Mel. T. Cook in Phytopathology 4: 277–278 (1914).

NEEDS OF THE DEPARTMENT.

A year ago the writer stated that the greatest need of the Department was for a larger force of men to take up the many problems which are demanding attention. Among the most urgent of these problems are:

(1) The diseases of the tomato. The tomato is one of the most important crops of the State, especially in the southern part. Heavy losses of this crop are due to the Leaf Blight *(Septoria lycopersici)* to Mosaic and to other diseases.

(2) The diseases of the sweet potato. The sweet potato is also an important crop in the southern part of the State. Heavy losses are due to Black Rot (*Sphæronema fimbriatum*) and to the Stem or Yellow Rot.

(3) The diseases of the legume crops. The number of complaints concerning the Root Rot *(Sclerotinia)* of the crimson clover, and other diseases of other legume crops, emphasizes the importance of timely work of this subject.

(4) The "Yellows" of the aster. This disease is causing heavy losses in many localities. It is not well understood and there is no satisfactory treatment.

(5) The diseases of the truck crops. The number of complaints concerning the diseases of truck crops are increasing rapidly and this work is sufficient to take the time of one or more workers.

(6) The diseases of ornamentals. The growing of ornamental plants is a much greater industry than most of us realize. The number of inquiries from growers of these crops is increasing rapidly and the work demands the attention of competent investigators.

VISITORS.

A number of scientists have visited the Station during the year. Among them we may mention: Dr. R. A. Harper, Professor of Botany in Columbia University; Dr. A. B. Stout, of the New York Botanical Garden; Dr. Haven Metcalf, Dr. W. A. Orton and Professor J. Franklin Collins, of the United States Bureau of Plant Industry; Dr. Otto Appel, Berlin, Germany; Dr. H. T. Gussow, Central Experiment Farms, Ottawa, Canada; Dr. T. F. Manns, Delaware Agricultural Experiment Station.

Alfalfa.

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease continues to be fully as severe as in the past. There have been

a great many inquiries concerning it and it is no doubt the cause of much greater losses than we realize. There has also been a great deal of complaint concerning a peculiar yellowing of the plants for which we have no satisfactory explanation.

Ampelopsis.

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.) This continues to be prevalent on the lower leaves of the plant, but cannot be considered serious except in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidatum.*

LEAF SPOT (*Sphæropsis hedericola* Speg. & Sacc.). On dead or dying leaves of *A. tricuspidata.* Cannot say that it was the cause of the dying. Collected by Mr. J. P. Helyar. (Also on *Hedera helix.*).

DIE BACK (*Cladosporium* sp.). This disease was much less severe in 1914 than in 1913, which can probably be attributed to the greater amount of rainfall. The disease was especially severe on the ivy on the Rutgers College Buildings in 1913. In the spring of 1914 the vines were given a heavy application of fertilizer and during the entire summer were given an abundance of water. Although the fungus can be found on the old mummy berries, there has been very little evidence of the disease on the vines. A description of this disease was published in Phytopathology 4: 189, 190 (1914).

Apple.

JONATHAN SPOT (*Alternaria* sp.). We are still uncertain as to the cause of this disease, but our studies indicate *Alternaria.* The disease occurred in the orchard and was frequently quite severe in storage.

BLOSSOM END ROT (*Alternaria* sp.). This disease was prevalent. *Alternaria* was very generally found in the diseased fruit and *Sphaeropsis malorum* was frequently associated with it.

ANTHRACNOSE or BITTER ROT (*Glomerella rufomaculans* [Berk.] Spauld. & Von Schenk). There was very little of this disease.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). This very common and well known disease was less severe than in 1913.

SCAB (*Venturia pomi* [Fr.] Wint.). This disease, which has been so severe for the past two years, especially in 1913, was of very little importance. There was not a single complaint from the growers.

BLOTCH (*Phyllosticta solitaria* E. & E.). Common, especially on Smith cider, but not so abundant as in 1913.

SPRAY INJURY. A few complaints.

RUST (*Gymnosporangium macropus* Lk.). Occasional. No importance.

WINTER INJURY. A few reports.

WATER CORE. A few reports on fall pippin.

PINK ROT (*Cephalothecium roseum* Cda.). A few reports. Not important.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Abundant throughout the State. Found to be very destructive on William Early Red eight-year old orchard.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

SOOTY BLOTCH (*Leptothyrium pomi* [Mont. & Fr.] Sacc.). Abundant on unsprayed orchards.

Ash.

DIE BACK (cause undetermined). In forest nursery on the College Farm.

Aster.

RUST (*Coleosporium solidaginis* [Schw.] Thum.). One report.
YELLOWS. This disease was so severe as to be an epidemic in many localities. It was the cause of heavy losses.

Beans.

MILDEW (*Phytophthora phaseoli* Thaxter). Severe on lima beans in Middlesex and Warren counties during July and August.
ANTHRACNOSE (*Colletotrichum lindemuthianum* [S. & M.] B. & C.). Abundant throughout the State.
POD BLIGHT (*Phoma subcircinata* E. & E.). Severe on lima beans throughout the southern part of the State.
LEAF SPOT (*Phyllosticta phaseolina* Sacc.). Common throughout the southern part of the State.

Beet.

LEAF SPOT (*Cercospora beticola* Sacc.). Common.

Blackberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common but of no great importance.
LEAF SPOT (*Septoria* rubi West.). Common but of no great importance.
RUST (*Gymnoconia peckiana* [Howe] Tranz). Common throughout the State. Some reports indicate that it was very destructive.

Boxwood.

LEAF AND STEM DISEASE (*Volutella buxi* [Cda.] Berk.). Found quite severe in one nursery.

Cabbage.

CLUB ROOT (*Phasmodiophora brassicæ* Wor.). Reported from various parts of the State and quite severe in some places.
BLACK ROT (*Pseudomonas campestric* [Pamm.] E. F. Smith.). Occurs in northern part of the State.

Catalpa.

LEAF SPOT (*Cercospora* Wint.). Common.
LEAF SPOT (*Phyllosticta catalpæ* E. & M.). Common.

Cannas.

YELLOWS. A peculiar disease causing a variegation of foliage and dwarfing of plants found in one nursery.

Carnation.

RUST (*Uromyces caryophyllinus* [Schrk.] Schroet). Very common.
BUD ROT (*Sporotrichum anthophilum* Peck). One report.

Cauliflower.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). One report.

Cedar.

RUST (*Gymnosporangium macropus* Lk.). Common but not abundant.

Celery.

BACTERIAL ROT (*Bacillus carotovorus* Jones). Very severe in the northern part of the State.
LEAF BLIGHT (*Cercospora apii* Fr.). Abundant.
LEAF BLIGHT (*Septoria petroselini* var. *Apii*). Abundant.
HOLLOW STEM (Cause?). One report.

Chard.

LEAF SPOT (*Cercospora* sp.). One report.

Cherry.

BROWN ROT (*Schlerotinia fructigena* [Pers] Schr.). Not severe.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common.
MILDEW (*Podosphæra oxyacanthæ* [D. C.] D. By.). One report.

Chestnut.

BLIGHT (*Endothia parasitica* Murrill). Abundant.

Citron.

LEAF SPOT (*Cercospora citrullina* Cke.). One report.

Clover.

LEAF SPOT (*Pseudopeziza trifolii* [Pers.] Fckl.) on red clover. One report.
ROOT ROT (*Sclerotinia trifoliorum* Erik). Reported.

Corn.

SMUT. (*Ustilago zeæ* [Beckm.] Ung.). Common.
WILT (*Pseudomonas stewarti* E. F. Smith). Several reports.

Cow Pea.

LEAF SPOT (*Cercospora* sp.). Common.

Crab (Flowering.)

RUST (*Gymnosporangium germinale* [Schw.] Kern.). One report.

Cucumber.

MILDEW (*Plasmopara cubensis* [B. & C.] Humph.). Common.

Currant.

ANTHRACNOSE (*Gloeosporium ribis* [Lib.] Mont. & Desm.). Common.
LEAF SPOT (*Septoria ribis* Desm.). Common.

Dahlia.

DWARFING (Cause unknown). One report. Somewhat similar to yellows.

Dewberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common but of no importance.
DOUBLE BLOSSOM (*Fusarium rubi* Wint.). Abundant and injurious.
LEAF SPOT (*Septoria rubi* West.). Common.
RUST (*Gymnoconia peckiana* [Howe] Franz). Common.

Egg Plant.

LEAF SPOT (*Phyllosticta hortorum* Speg.). Abundant throughout the State.

WILT (Cause?). Abundant throughout the State.

Grape.

BLACK ROT (*Guignardia bidwellii* [Ell] Viola & Ravaz). Abundant and cause of heavy losses in some places.

LEAF SPOT (*Isariopsis clavispora* Sacc.). In one vineyard on Elvira. Very severe.

LEAF SPOT (*Cryptosporella viticola* Shear.). One record. Not serious.

MILDEW (*Plasmopara viticola* [B. & C.] B. & DeT.). Abundant but not serious.

FRUIT ROT (*Phoma* sp.). One record.

SPRAY INJURY. Two records.

Hollyhock.

RUST (*Puccinia malvacearum* Mont.). Common.

Horse Chestnut.

LEAF SPOT (*Phyllosticta sphæropsidea* E. & E.). Common.

MILDEW (*Uncinula flexnosa* Pk.). Occasional.

Larkspur.

WILT. Unidentified sclerotial fungus. One report.

Lilac.

LEAF SPOT (*Phyllosticta halstedii* E. & E.). Common.

MILDEW (*Microsphaera alni* [Wallr.] Wint.). Common.

Maple.

ANTHRACNOSE (*Gloeosporium apocryptum* E. & E.). On Norway maple. Serious on young trees in the nursery.

BARK DISEASE (*Nectria cinnabarina* or *N. coccinea.*). Tubercularia stage only. One report.

LEAF SPOT (*Phyllosticta acericola* C. & E.). On soft maple. Common.

Oats.

SMUT (*Ustilago levis* [K. & S.] Magnus). Common.

SMUT (*Ustilago avenæ* [Perl.] Jens). Common.

RUST (*Puccinia coronata* Cda.). Common.

Okra.

WILT. (*Verticillium* sp.). Common in South Jersey.

Peach.

BROWN ROT (*Sclerotinia fructigena* [Pers] Schr.). Abundant in unsprayed orchards.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Common. Trees affected with this disease appear to be more subject to other diseases than healthy trees.

LEAF CURL (*Exoascus deformans* [Berk] Fuckel). Abundant in orchards which were not properly sprayed.

LITTLE PEACH. Abundant and cause of heavy losses over the State.

SCAB (*Cladosporium carpophilum* Thum.). Abundant in unsprayed orchards.

SHOT HOLE (*Bacterium pruni* E. F. Smith). Abundant in certain localities of South Jersey. Most severe on Elbertas.
SHOT HOLE (*Cercospora circumscissa* Sacc.). One report.
SPRAY INJURY. Common.
WINTER INJURY. Common.
YELLOWS. Abundant and the cause of heavy losses.

Pear.

FIRE BLIGHT (*Bacillus amylovorus* [Burr] De T.). Less severe than in 1913.
FRUIT SPOT (*Fabræa maculatum* [Lev.] Atk.). Common.
LEAF SPOT (*Septoria pyricola* Desm.). Common. Not serious.
SCAB. (*Venturia pyrina* Aderh.). Common.

Pepper.

FRUIT ROT (*Colletotrichum nigrum* E. & H.). Common.
FRUIT ROT (*Gloeosporium piperatum* E. & E.). Common.
ROOT ROT (Cause?). Common.

Pine.

ROOT DISEASE (*Mycorhiza*). Common.

Plane Tree.

ANTHRACNOSE (*Gnomonia veneta* [S. & S.] Kleb.). Common.

Plum.

BROWN ROT (*Sclerotinia fructigena* [Pers.] Schr.). Abundant in unsprayed orchards.
LITTLE PLUM. Common.
BLACK KNOT (*Plowrightia morbosa* [Schw.] Sacc.). Common.

Poplar.

CANKER (*Rhabdospora* sp.). One report. Causing die back of twigs.
BLIGHT (*Marsonia populi* [Lib.] Sacc.). One report.

Potato.

BLACK LEG (*Bacillus phytophthorus* Appel.). Much less than in 1913.
EARLY BLIGHT (*Alternaria solanii* [E. & M.] Jones & Grout.). Common.
LATE BLIGHT (*Phytophthora infestans* [Mont.] De Borg.). Two records on seed potatoes in spring. Very abundant in North Jersey in the fall.
CURLY TOP. Frequent. This is the first report of this disease in New Jersey.
DRY ROT (*Fusarium oxysporum* Schl.). Occasional.
SCAB (*Oospora scabies* Thax.). Abundant.
SILVER SCURF. (*Spondylocladium atrovirens* Appel & Laubert.). Occasional.
SCURF (*Rhizoctonia* or *Corticium vagum* B. & C. O. var. *Solani* Burt.). Abundant.
SPRAY INJURY. Frequent.

Quince.

BLACK ROT (*Sphæropsis malorum* Pk.). Common.
FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De T.). Common but less severe than in 1913.
LEAF SPOT (*Fabræa maculatum* [Lev.] Atk.). Common.
RUST (*Gymnosporangium germinale* [Schw.] Kern.). One record.

Raspberry.

ANTHRACNOSE (*Glœosporium venetum* Speg.). Abundant and frequently severe.

CANE BLIGHT (*Cytospora rubi.* Schw.). One record.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common and very severe in northern part of the State.

CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Abundant and severe.

LEAF SPOT (*Septoria rubi* Westd.). Abundant.

Rose.

BLACK SPOT (*Actinonema rosæ* [Lib.] Fr.). Abundant.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Severe in northern part of State.

MILDEW (*Sphærotheca pannosa* [Wllr.] Lev.). Very common.

INTUMESCENCE. One report on roses under glass. Probably due to application of sulphur. Not serious.

Snap Dragon.

ROOT ROT (*Thielavia basicola* [B. & Br.] Zopf.). One record. Cause of serious loss.

Strawberry.

LEAF SPOT (*Mycosphærella fragariæ* [Tull.] Lindau.). Common.

Sunflower.

RUST (*Puccinia helianthii* Schw.). Common.

Sweet Potato.

BLACK ROT (*Sphæronema fimbriatum* [E. & H.] Sacc.). Abundant.

STEM ROT (*Fusarium batatatis* Wollenw)*. Abundant.

Tomato.

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). Abundant and destructive.

BLOSSOM END ROT. (Cause?). Less common than in 1913.

FILIFORM LEAF. Occasional.

LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and the cause of heavy losses.

WILT (*Fusarium lycopersici* Sacc.). A condition of plants which indicates this disease.

Turnip.

LEAF MOLD (*Macrosporium herculeum* E. & L.). One record.

Watermelon.

ANTHRACNOSE (*Colletotrichum lagenarium* [Pass] E. & H.). Abundant in southern part of the State.

Wheat.

RUST (*Puccinia graminis* Pers.). Common.

SMUT (*Ustilago tritici* [Pers] Jens.). Common.

SMUT (*Tilletia fœtens* [B. & C.] Trel.). Occasional.

In addition to the above list, our records show a very large number of diseases of minor importance on ornamentals and wild plants.

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*This disease was formerly attributed to *Nectria ipomœa* Hals.

Report of Potato Scab Experiments, 1914.

By H. CLAY LINT.

The investigations of the Department of Plant Pathology relating to potato scab have been confined largely to the testing of materials used to aid in the control of the disease. The disease is caused by the definite fungus *Actinomyces scabies** Thaxt., Gussow. It is very widely distributed in all of the potato growing sections of New Jersey, and in many places the attack is so severe as to render a portion of the yield unsaleable. The disease is especially severe on the Green Mountain and Irish Cobbler varieties. On the American Giant, a variety cultivated in the middle sections of Jersey, the scab seldom develops so far as to render many of the tubers unsaleable. In many sections it is desirable to grow this crop on the same soil for a number of years and in these localities the scab is a problem of considerable economic importance.

There are two methods of attacking this disease: *First*, an effective treatment of the seed so as to eliminate this source of infection. *Second*, a soil treatment in cases where the soil has become infected with the organism.

The first effective treatment of the seed potatoes was accomplished by Bolley (1) by means of soaking the seed potatoes in an aqueous solution of corrosive sublimate ($HgCl_2$). Shortly afterward Arthur (2) introduced the formalin treatment of the seed potatoes. This likewise consists in soaking the seed, the standard strength recommended at the present time being one pint of 40 per cent. formalin solution to 30 gallons of water. The period of soaking should extend from one and one-half to two hours.

Experimental tests and practical experiences have long ago demonstrated the effectiveness of both of these treatments. For the scab alone there is little difference either in effectiveness or cost between the two methods of treatment. Recently evidence has been presented to show that the corrosive sublimate is more effective against the potato scurf (*Rhizoctonia* or *Corticium vagum* var. *solani*) than formalin. The former is, however, a deadly poison and not to be recommended to those who are not familiar with its properties. Because of the equal effectiveness of these substances in the control of scab and because of the danger attendant upon the use of corrosive sublimate, the Department has generally recommended the formalin.

Seed treatment is very generally recognized in this State as a profitable practice.

Dr. Halsted (3) of this Station tried out a number of materials for the control of the potato scab organisms in the soil during the interval from 1895 to 1900. The most promising proved to be sulphur. He used various rates of application, obtaining best results with amounts of about 600 pounds per acre. Considering the favorable nature of the results and the

*Sym. *Oopora scabies* (Thaxt.)

opportunities that this work presented for further study, this line of investigation has been taken up again. This work has been made possible through an industrial fellowship established in this Department by the Union Sulphur Company of New York City.

Many investigators, both in this country and abroad, have employed sulphur for the purpose of scab eradication; the results vary widely and are sometimes contradictory.

Brooks (4) at Massachusetts tried out sulphur in much the same manner as was done in this State. He failed to obtain any appreciable benefits from its use, the average increase in the clean potatoes being around six per cent.

Wheeler (5) and collaborators at Rhode Island tried out a large number of materials, including sulphur, for scab control. Only small benefits resulted from the use of sulphur with the potatoes and it was found that on soils which were acid or only slightly alkaline there was a distinct injurious effect on the succeeding crops.

In 1910-11 Bernhard (6) at Ahrvilles (France) published results which showed the sulphur to be very effective in the control of scab. E. Boullanger (7) at Lille (France) investigated the fertilizing action of sulphur on various crops, including potatoes, and found an increase in the yield of 20 per cent. due to applications of sulphur. M. A. Demolon (8) and E. Chancrin and A. Desroit (9) likewise report an increased yield due to applications of sulphur to potatoes. These latter used sulphur at the rate of 250 and 500 Kg. per hectare, equivalent to 223 and 445 pounds per acre, respectively.

J. Veicier (10) in 1913 reported an increased yield due to applications of sulphur, also an earlier maturity of the crop from six to eight days. Hialmar von Feileitzen (11) at Jonkoping in Sweden reports favorable results in scab control from applications of sulphur in the case of some varieties but finds an injurious effect on the succeeding crops.

EXPERIMENTS IN NEW JERSEY IN 1914.

In considering the problems connected with the application of sulphur there appear at once a number of factors which cannot but have a material influence on the efficiency of the fungicide. Our lines of investigation, therefore may be stated.

First: The influence of cover crops on the control of scab accomplished by sulphur. Where growers care to produce crops of potatoes on the same soil for a number of years, the common practice is to sow a cover crop each year. This is ordinarily planted as soon after the digging as possible. Crimson clover, either alone or in mixture with a non-legume, has become very popular for this purpose within recent years.

Second: The influence of the time of application of the sulphur. It was noticed that at digging time a great proportion of the sulphur which had been applied in the spring was present in the soil, apparently unchanged. Such evidence would tend to show that the oxidation of the sulphur under the conditions of the soil was being accomplished very slowly. If the fungus control is accomplished because of the sulphuric acid formed by the oxidation of the sulphur, it would appear possible to obtain better results by making the application in the fall, thus giving a longer time for changing the nature of the element in the soil. Based on these observations, we have tried out fall versus spring application of the sulphur.

Third: The influence of the formalin treatment of seed potatoes on the control of the scab. In this connection we have used the formalin alone as a combatting measure, as we recommend to the growers. In the formalin tests we have run plots which received applications of sulphur so that we have data not only on each of the preventative measures but also on the combination of the two.

Fourth: The influence of the method of application. In the experimental work that has been done with sulphur quite a number of different methods of application have been used. Some would be highly impracticable on a large scale so that in our work we have tested out the influence of three methods of application which are possible on a commercial scale. They are: (a) Broadcasting the sulphur. With this method the comparison was made of application before and after planting. (b) Mixture of the sulphur with the fertilizer. (c) Placing the sulphur in a narrow strip on top of the row after the time of planting.

Fifth: The influence of the form in which the three essential elements, Nitrogen, Phosphoric Acid and Potash, are found in the fertilizer. Upon this phase of the problem we have compared: (a) Sulphate of potash with muriate of potash as a source of potassium. (b) Acid phosphate with steamed bone as a source of phosphoric acid. (c) Nitrate of soda with ammonium sulphate as a source of nitrogen.

A number of experiments have been conducted on different soils in various parts of the State to determine the varying results dependent on the texture, origin and past treatments.

No potato growers with whom the Experiment Station is in touch attempt to grow a crop without fertilizer. The common formula of the fertilizer used is 4-8-10 and the rate of application will range between 1,200 pounds and one ton per acre. In our work we have been unable to compare the effectiveness of the sulphur with and without fertilizer.

The various points outlined above have been covered by 18 different experiments ranging in size from 3 to 18 plots each, as follows: Cumberland County, 5 experiments; Salem County, 5 experiments; Gloucester County, 2 experiments; Mercer County, 1 experiment; Monmouth County, 3 experiments; Middlesex County, 1 experiment; Sussex County, 1 experiment.

In general, our ideal has been to employ plots of at least one-fifth of an acre in size and at least five rows wide. Where the length of the field has been over 600 feet, we were able to carry out this plan. In cases where the row length is less than 600 feet, we have compensated by increasing the plot width. In some of our experiments the plot areas have been as large as one-half acre. We have insisted on at least five rows so that the middle rows would not be influenced by outside conditions.

Only the two middle rows of each plot were used for obtaining data. The potatoes were sorted into clean and scabbed in cases where the entire yield was saleable. In others we have formed a third class of unsaleable scabbed potatoes. In our experiments, especially when the scab is very severe, the data shows relative scab rather than absolute numbers of clean and scabbed potatoes. For instance, in one experiment where 25 per cent. of the yield was unsaleable because of scab. In this field it is entirely probable that there was not one potato free from scab; yet under those conditions one finds a larger number of potatoes on the

sulphur plots that have but a few scab spots than on the check plots, it is fair to attribute this condition to the sulphur. Under the old methods of grading into clean and scabbed all plots would be 100 per cent. scabby with no comparative results.

The opposite conditions prevailed in some of our experiments, where as high as 85 per cent. were absolutely clean. In this case the minutest lesions were enough to discard the tuber from the class of clean potatoes. It will be readily seen that our scale has been flexible, depending upon the amount of scab present, but that in sorting the potatoes from any one experiment that the standard has been fixed.

That the yields might have a more impressive character we have figured them into bushels per acre rather than into pounds per plot. The per cents. of each are figured from the actual weights of clean and scabbed potatoes.

The influence of the various factors on the effectiveness of the sulphur are considered separately.

I. Influence of cover crop.

(a) On the yield. The results of this year's experiments have shown very remarkable increases in the yields due to the growth of a cover crop. An average of the yields from all the non-cover crop and cover crop plots in four experiments is given in the following table:

YIELDS IN BUSHELS PER ACRE.

Farm of	Post-office.	Cover crop plots.	No cover crop.
D. H. Jones	Freehold	244.9	221.5
Elbert Kirby	Mullica Hill	215.1	195.8
J. L. Bitters	Roadstown	117.6	96.6
J. H. DuBois	Freehold	276.2	254.3
Total		853.8	768.2
Average		213.45	192.05

Average increase due to cover crop, 21.4 bushels.

(b) Regarding the influence of the cover crop on the efficiency of the sulphur we find that the sulphur does not increase the per cent. of clean tubers as much on the cover crop plots as on the non-cover crop plots. On the farm of John H. DuBois at Freehold we found 39.95 per cent. of clean potatoes on a cover crop check plot with 48.20 per cent. of clean tubers on the corresponding sulphured plot. This gives an increase of 8.25 per cent. of clean potatoes due to sulphur application. On the non-cover plot areas the check shows 45 per cent. clean potatoes, while the corresponding sulphured plot shows 63.45 per cent. of clean potatoes. Here the increase in the number of clean potatoes is 18.45 per cent. In other words the sulphur is a little better than twice as effective on non-cover crop soil as on soil which has just previously grown a cover crop.

Even more striking results were obtained on the farm of D. Howard Jones, whose potato field under experiment lies less than a quarter of a mile from the DuBois farm and has the same type of soil. On the non-cover crop plots the sulphur increased the per cent. of clean tubers from 35.90 to 59.08, a difference of 23.18 per cent. On the cover crop plots the increase was only 4.61 per cent. The sulphur here was about five times as effective on the non-cover cropped areas.

II. Influence of time of application on the efficiency of the sulphur.

(a) Our experiments with fall versus spring applications have shown very clearly that the spring application is much more efficient, especially on soils where there has been no cover crop grown. The following experiment will serve to illustrate this point:

EXPERIMENT WITH D. H. JONES, FREEHOLD, N. J.

Plot treatment.	Per cent. clean tubers.	Bushels per acre.
Check, no sulphur	47.66	244.5
Sulphur broadcasted in fall	52.27	259.8
Check, no sulphur	47.66	239.5
Sulphur broadcast in spring	74.57	226.3

This experiment shows an increase in the number of clean potatoes of 4.61 per cent. due to fall application as compared with a difference of 26.91 per cent. due to spring application. These results are also interesting from the yield standpoint where the fall application gives an increased yield of 15.3 bushels per acre over its check, while the spring application gives a decrease of 13.2 bushels per acre. It is true that we find a normal variation of five bushels per acre in the yield on the two checks, but where the differences are nearly three times the normal variation they must be attributed in part to the varying factor, which in this case is the time of sulphur application.

(b) Another phase of the problem of time of application presents itself. On the farm of E. C. Conover, at Freehold, which lies near that of D. H. Jones and has the same type of soil, there was obtained a 26.52 per cent. increase in the number of clean potatoes due to applications of sulphur. At the Jones farm, as before stated, the difference obtained was 27 per cent. In the former case the sulphur was applied the first day of June and in the latter the application was made April 18th. Whether or not the time for spring application extends over so long a time with the possibility of equally good results is well worthy of further study.

III. Influence of formalin treatment of the seed in the control of the potato scab.

For all of our experiments this year we have tried to select a soil that was badly contaminated with the scab organism. Obviously it is much more difficult to show benefits of seed treatment in cases where the soil is infected, because only one of the sources of infection has been removed. On this point Sherbakoff (12) states that "When the soil becomes contaminated with the scab germ, seed treatment is of no value unless some method can be devised for eradicating the germ in the soil." Despite the fact that our experiments with seed treatment have been run under just such adverse conditions as outlined above, we have been able to show beneficial results from three standpoints.

(a) Influence of the formalin treatment on the scab control.

An average of two check plots with formalin treated seed gives 19.10 per cent. clean potatoes as compared with an average of 14.99 per cent. with untreated seed. These results were obtained in cooperation with Mr. Robert Fogg at Salem, N. J., on soil that was badly infested with the organism. The above point is also illustrated in the table given below

from the data obtained in our experiment with Clifford Flitcraft at Elmer. Here we have 28.45 per cent. clean potatoes on plots seeded with untreated tubers against 37.95 per cent. clean potatoes from the formalin treated seed.

(b) Influence of the combined sulphur and formalin treatments.

By a combination of the formalin treatments of the seed and the sulphur treatment of the soil we have been able to obtain data that are very favorable both to the formalin and the sulphur. Data from four plots of one experiment with Mr. Flitcraft at Elmer will serve to illustrate this point.

Plot No.	Sulphur.	Seed.	Per cent. clean.	Per cent. unsalable.
1.	600 lbs. per acre.	Untreated.	57.40	3.35
2.	Check, no sulphur.	Untreated.	28.45	23.52
3.	Check, no sulphur.	Treated.	37.95	13.51
4.	600 lbs. sulphur per acre.	Treated.	74.80	4.93

Comparison of plots 2 and 3 show not only 9.5 per cent. more clean potatoes due to formalin treatment, but also 10 per cent. less unsaleable tubers. The fact that nearly one-fourth of the crop was unsaleable because of scab on the plot where no treatment was given proves beyond question that there was bad infestation of the soil. Such marked benefits from the formalin treatment under these adverse conditions exceeded our expectations.

With regard to the sulphur it is interesting to note how much more effective the sulphur has been in the case of the formalin treated seed. A comparison of plots 1 and 2 shows a difference of 28.95 per cent. in the number of clean potatoes due to the sulphur application. A similar comparison of plots 3 and 4 gives a difference of 36.85 per cent. Obviously the sulphur is much more efficient where it has only the scab in the soil with which to contend. From the practical standpoint the sulphur here has been very beneficial in that it has rendered practically the entire yield saleable where one-fourth of the yield would otherwise have been unmarketable.

(c) Influence of the formalin treatment on the yield.

It has been the experience of a number of growers that formalin treatment has given larger yields. The reason for this is not satisfactorily explained to date although the fact is pretty well established. These averages of six plots on the farm of Robert Fogg, Salem, N. J., with formalin treatment as compared with six plots entirely similar save that they were planted with untreated seed gives the following results:

Average yield for formalin treated seed, 138.4 bushels per acre.

Average yield for non-treated seed, 133.6 bushels per acre.

In other words, one can figure on enough increase in the yield due to formalin treatment to pay for the material and labor.

IV. The influence of the method of application on the efficiency of the sulphur.

Our tentative conclusions of this phase of the sulphur question may be summed up as follows: (1) Broadcasting of the sulphur has given slightly better results than the mixture of the sulphur with the fertilizer. (2) Broadcasting of the sulphur after planting gives better results than broad-

casting before planting. In the latter case the sulphur becomes well integrated in the surface soil which inhibits the rapid oxidation possible where the sulphur is not so mixed. (3) The application of sulphur in a narrow strip on top of the rows after planting has given better control of the scab than broadcasting at this time. In this method the amount of application is practically doubled since only half of the surface of the soil is covered. Linked with the higher efficiency of the sulphur due to this method of application we find the greatest decreases in yield.

Undoubtedly, the most convenient method of applying sulphur to the soil would be to have it mixed with the fertilizer. Our work would tend to show that the best place to have the sulphur is near the surface of the soil and with some types of distributers the fertilizer is placed below the level of the seed piece. Obviously, the fungicidal effect of the sulphur in this place is much impaired. More recent fertilizer attachments of potato planters put the fertilizer near the surface and above the seed piece and the results at Freehold this year in which the mixture of fertilizer and sulphur was applied with this type machine showed almost as good control as did broadcasting. From the evidence at hand on this point it is doubtful whether the slightly better results from broadcasting over mixture with the fertilizer will compensate for the extra labor involved.

V. Influence of the form of the fertilizer elements on the efficiency of the sulphur.

In all of the experiments covering this phase of the work we have used 1,400 pounds of complete 4-8-10 fertilizer per acre. They were made up exactly alike save for the one element in question: acid phosphate versus steamed bone in the one case, $NaNO_3$ versus $(NH_4)_2SO_4$ in another and KCl versus K_2SO_4 for the third. Tentative conclusions on the phase of the sulphur problem follow:

(a) Sulphur makes a larger increase in the per cent. of clean potatoes with KCl than with K_2SO_4. This is illustrated in the following table of results obtained on the farm of Joseph Fogg at Bridgeton, N. J.:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
KCl	Check, no sulphur.	11.94	8.30
K_2SO_4	Check, no sulphur.	10.82	0.61
KCl	300 lbs. sulphur per acre.	23.07	0.655
K_2SO_4	300 lbs. sulphur per acre.	13.67	1.63
KCl	600 lbs. sulphur per acre.	27.70	1.93
K_2SO_4	600 lbs. sulphur per acre	20.65	1.40

(b) Sulphur seems to have a greater fungicidal effect with acid phosphate than with steamed bone as a base in the fertilizer. This is shown in the following table:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
Steamed bone	Check, no sulphur.	20.00	6.42
Acid phosphate	Check, no sulphur.	11.94	8.30
Steamed bone	300 lbs. sulphur per acre.	20.55	2.74
Acid phosphate	300 lbs. sulphur per acre.	23.07	0.655
Steamed bone	600 lbs. sulphur per acre.	26.48	2.56
Acid phosphate	600 lbs. sulphur per acre.	27.70	1.93

(c) Sulphur makes a much greater increase in the cleanliness of the potatoes in combination with $(NH_4)_2SO_4$ than with $NaNO_3$. This point is illustrated by the following results:

Fertilizer.	Treatment.	Per cent. clean.	Per cent. unsalable.
$NANO_3$	Check, no sulphur.	9.75	0.00
$(NH_4)_2SO_4$	Check, no sulphur.	9.75	0.00
$NaNO_3$	300 lbs. sulphur per acre.	20.90	0.00
$(NH_4)_2SO_4$	300 lbs. sulphur per acre.	31.00	0.00
$NaNO_3$	600 lbs. sulphur per acre.	28.18	0.00
$(NH_4)_2SO_4$	600 lbs. sulphur per acre.	35.30	0.00

VI. Influence of the rate of application.

In general we have been able to obtain but little decrease in the amount of scab due to applications of 300 pounds of sulphur per acre. The results from applications of 600 pounds of sulphur have in some cases been very remarkable. The results of Series "D" experiments with Minch Brothers at Bridgeton, N. J., show the best scab control obtained in any of our experiments.

Plot No.	Sulphur treatment.	Per cent. clean.	Per cent. medium scabbed.	Per cent. unsalab e.
1.	600 lbs. sulphur per acre.	55.10	44.60	00.30
2.	Check, no sulphur.	00.30	89.10	10.60
3.	300 lbs. sulphur per acre.	5.10	91.20	3.70

In order to illustrate the average result to be expected from the application of sulphur in these two rates, the averages of the plots of the following experiments are cited and the general average taken. In all these experiments we have plots with 300 pounds sulphur per acre, 600 pounds sulphur per acre and the corresponding checks. The table of averages follows:

Cooperation with	Post Office.	No. plots in the experiment.	Per cent. clean on check plots.	Per cent. clean on 300 lbs. sul. per acre plots.	Per cent. clean on 600 lbs. sul. per acre plots.
E. C. Conover	Freehold	3	32.18	34.40	58.70
Jos. H. Fogg	Bridgeton	18	15.05	26.52	27.03
Minch "D"	Bridgeton	3	00.30	5.10	55.10
Edw. Ackerson	Lafayette	8	82.48	85.35	86.65
Elbert Kirby	Mullica Hill	9	29.60	41.44	50.20
Flitcraft "A"	Elmer	7	38.92	49.44	57.15
Minch "B"	Bridgeton	12	4.53	9.78	9.44
Minch "A"	Bridgeton	12	15.38	22.66	22.38
John Ballinger	Mullica Hill	9	13.81	25.52	35.51
Total		...	232.25	300.22	402.16
Average			25.80	33.36	44.57

The influence of the sulphur on the yield has been somewhat varied. This influence seems to depend a great deal upon th acidity of the soil, also upon the texture. Most potato soils are acid, the lime requirement ordinarily varying from 800 to 1,800 pounds of CaO per acre. It is not difficult to understand that a decrease in the yield might result purely because of too acid conditions of the soil when the sulphur is added under such circumstances. In general the application of sulphur has resulted in a decrease in the yield. However, the data cited below where the sulphur produced an increased yield will show within how wide a range the results in this particular line may vary. The following table shows the results of an experiment on the farm of C. W. Stevens, Jr., on the red shale, clay loam soil near New Brunswick.

Plot No.	Sulphur Treatment.	Yield in Bushels per acre.
1.	Check.	41.10
2.	300 lbs. sulphur per acre.	59.40
3.	600 lbs. sulphur per acre.	51.35
4.	900 lbs. sulphur per acre.	59.80

Here we find an increase of about 30 per cent. in the yield in two out of three of the sulphur plots. This soil is strictly speaking not a potato soil and has not been subjected to the treatments accorded the normal potato soils. This soil is also very nearly neutral, another item which is contrary to the normal condition in potato soils. It has been our experience that the danger of injury from the sulphur is much more prevalent on a light soil than on the heavier types.

To get at the average and normal result to be expected on the yield from the application of sulphur, we have prepared the following table of average yields from eight of the experiments used in making the per cent. of scab table. These averages follow:

	YIELDS IN BUSHELS PER ACRE.		
In cooperation with	On checks.	300 lbs. sul. plots.	600 lbs. sul. plots.
E. C. Conover	388.0	375.0	360.5
Joseph Fogg	82.75	87.35	85.1
Edw. Ackerson	166.2	164.1	152.2
Elbert Kirby	220.0	207.8	196.4
Flitcraft "A"	99.87	99.4	100.97
Minch Bros. "A"	123.3	123.3	138.6
Minch Bros. "B"	149.4	137.8	143.4
John Ballinger	166.6	133.5	141.85
Total	1398.12	1327.9	1319.02
Average	174.74	165.98	164.88

Many other points of interest have been noted in connection with the sulphur work that have not been brought out in the data previously cited. On two out of fourteen experiments started in the summer of 1913 by John H. Voorhees, of the Extension Department, but later turned over to the Department of Plant Pathology, we have found injury to the succeeding hay crop. On the farm of R. M. Dilatush at Robbinsville and that of Frank Ridgeway at Woodstown the sulphur rows were marked entirely across the field by the absence of vegetation. The evidences of this injury disappared slowly and by the fall of 1914 no traces of the injury remained.

Acidity determinations of the soil from Mr. Dilatush's farm gave the following results:

Row Numbers.	Lime requirement in pounds CaO per acre.
Row 1—Check	883
Row 2—300 lbs. sulphur per acre applied	2247
Row 3—600 lbs. sulphur per acre applied	3025
Row 4—300 lbs. sulphur per acre applied	2590
Row 5—600 lbs. sulphur per acre applied	3187

Crimson clover seems particularly susceptible to injury and in most instances the injury can be attributed to the high acidity of the soil.

Showing detrimental effect on the succeeding hay crop on the farm of Frank Ridgeway at Woodstown, N. J. The Sulphur was applied in mixture with the fertilizer and bare streaks show the position of potato rows.

Another fact noted on sulphur plots is that the skins of the potatoes are almost invariably lighter in color, and presumably finer in texture. Even where there is no scab present this improvement in the appearance of the tubers has been observed.

With the Giant potatoes at Freehold we have obtained an earlier maturity of the crop by from six to ten days on the sulphur plots. In the case where the earlier maturity was most marked there was no decrease in the yield. Fall application of the sulphur does not produce this effect to nearly so marked a degree. It is interesting to note that this effect was not observed with Irish Cobbler and Green Mountain varieties.

In cases where the soil has been limed heavily within recent years we have not been able to obtain satisfactory results from sulphur in the control of the scab. It is well established that alkaline conditions favor the scab and as a general rule the need of remedial measures is felt most here. It is possible that the reason for this poor control lies in the fact that the oxides of sulphur would tend to combine with the alkali as soon as formed. A great part of the sulphur is oxidized to the trioxide which, with lime, would form land plaster or gypsum, a compound with little or no fungicidal property.

The experience of a number of growers has been that dusting the cut seed piece in sulphur is a good practice. Experimental work by Stoward (13) has shown that sulphur aids in the formation of an artificial skin over the cut surfaces which inhibits the evaporation of water. In cases where the seed pieces lie in the ground for several weeks before sprouting it is believed that sulphur will prevent rots of the tuber. Some writers have claimed partial control of the scab by this practice, but as a method of seed treatment against scab it is not to be compared with the formalin or corrosive sublimate treatments.

The possible place of sulphur in the system of potato culture.

From our results of this year it is apparent that the sulphur has either caused a decrease in the number of organisms in the soil or it has made the conditions so unfavorable as to destroy the virulence of the organism in part. How long this influence may last after the sulphur has been applied remains for further experimentation to determine. The results at Cornell show that the influence extends over at least the following year.

In cases where it is desired to follow potatoes with the same crop for a number of years the common experience has been that the scab attacks become worse. By using sulphur under these conditions one can practically be assured of a crop of 95 per cent. saleability.

There is also the possibility of using sulphur as a soil renovant. The actual eradication of the organism from the soil would probably take several years. Our results with the combined sulphur and formalin treatments point toward this possibility. Once the soil has been freed of organism one needs only to continue the formalin treatment to insure a clean yield.

The following summary of the sulphur work consists of tentative conclusions only, being based on but one year's work:

(1) Formalin treatment of the seed will decrease the scab even in badly infested soils and is again strongly recommended.

(2) Formalin treatment of the seed ordinarily results in an increased yield, large enough to more than pay the expense of treatment. It has been noted that where the seed has been treated the plants are much more uniform in their time of appearance above the surface of the soil.

(3) When applications of sulphur are made upon infested soils and the seed is treated we obtain a higher efficiency for each preventative measure. For example, formalin treatment under certain conditions might increase the yield of clean tubers 10 per cent. Sulphur under the same conditions might give a 10 per cent. increase also. By combining the two we might get a 30 per cent. increase instead of only 20 obtained by simple addition.

(4) Applications of sulphur at the rate of 600 pounds per acre decrease the scab normally 20 to 25 per cent.

(5) The growth of a cover crop, particularly of a legume, increases the yield from 10 to 20 bushels per acre.

(6) Sulphur is able to make a larger increase in the per cent. of clean potatoes on soil which has not produced a cover crop the year before than on a soil which has produced a cover crop.

(7) Fall application of the sulphur will decrease the scab only slightly. Fall applications have given increased yields in some instances where the corresponding spring application has resulted in a decrease in the yield.

(8) Broadcasting of the sulphur after planting gives better results than broadcasting before planting.

(9) Spring application is much more effective than fall application.

(10) Mixture of the sulphur with the fertilizer gives almost as good results as broadcasting, especially where the fertilizer is placed at a higher level than the seed piece.

(11) Spreading the sulphur in a narrow strip on top of the row after planting has given the best control of the scab. This method also results in the largest decreases in the yields.

(12) Sulphur has a greater fungicidal effect in combination with acid phosphate than with steamed bone.

(13) Sulphur makes a larger increase in the per cent. of clean potatoes when used with KCl than with K_2SO_4.

(14) Sulphur gives a greater increase in the per cent. of clean potatoes with $(NH_4)_2SO_4$ than with $NaNO_3$.

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Orchard Experiments—1914.

G. W. MARTIN.

The experiments with the use of finely divided sulphur as a spray treatment for apples and peaches, begun in 1913, were continued during the summer of 1914, in co-operation with the Department of Entomology.

Experiment With Peaches.

It was found undesirable to continue the peach experiments in the Repp orchard at Glassboro and difficulty was experienced in finding suitable plots. It was finally decided to conduct the work in the State Experimental Orchard at Vineland, made possible by the cooperation of Professor M. A. Blake, State Horticulturist. The plots were not ideal, as they were altogether too small and had been subjected to differences in fertilizing treatment, but these disadvantages were to some extent counterbalanced by the more direct control of the spraying treatments and by the certainty that securing of the final results would be assured.

The treatments were applied to five varieties, each variety in a single row and separated from the next row under treatment by a block of five rows of Elbertas. Each row was divided into blocks of five trees each, receiving respectively sulphur dust, sulphur paste, self-boiled lime-sulphur, Atomic sulphur and arsenate of lead only, the last as a check plot. The arrangement of plots is shown in the accompanying diagram. The self-boiled lime-sulphur was the regular 8-8-50 solution used for peaches, to which, in the early treatments, three pounds of paste arsenate of lead were added for the control of the curculio. The sulphur dust and paste were so applied as to put the same amount of sulphur on the trees that they would have received had they been treated with the self-boiled lime-sulphur. The atomic sulphur was used at the rate of five pounds to fifty gallons of water and arsenate of lead added as to the self-boiled mixture. The arsenate of lead alone was used at the rate of three pounds to fifty gallons. The intervening plots of Elbertas were all sprayed with self-boiled lime-sulphur.

	Dust	Paste	Lime-S.	Atomic-S.	Arsenate
Greensboro.....	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK OF ELBERTAS				
Waddell.....	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK OF ELBERTAS				
Mt. Rose.....	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK OF ELBERTAS				
Reeves Fav.....	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
	BLOCK OF ELBERTAS				
Carman.....	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX

All trees were sprayed with standard lime-sulphur solution at dormant strength on March 27th before the buds opened. The other treatments were given on May 6, May 21 and June 11. The Reeves, Mountain Rose and Carman plots were given an additional treatment on July 1.

The attempt to keep a record of the drops as was done last year had to be abandoned because of the pressure of other work but records were made of the crop as finally harvested. One of the central trees in each plot was selected as a count tree, the effort being made to select the tree which most nearly conformed to the average of the trees in the row. This selection was made just after the fruit was set and before any difference from the treatments could be apparent. All the peaches from such count trees were carefully put aside when the trees were picked and each peach was examined and graded as clean, slightly scabbed, badly scabbed, slightly marked by curculio, badly marked by curculio, slightly marked with scab and curculio and badly marked by scab and curculio. A peach was graded as clean only if it showed absolutely no sign of scab and no curculio mark. It was graded as slightly scabbed if there were found from one to a dozen scab marks, and in some cases where there were more than a dozen, if they were small and inconspicuously placed, as at the stem-end cavity. Anything more serious than this was graded as badly scabbed. From one to three or four feeding punctures of the curculio, provided the peach was not injured in appearance more than those classed as slightly scabbed, caused it to be graded as slightly marked by curculio. Several slight marks, or only one, if it caused any considerable distortion of the fruit, caused a peach to be graded as badly marked. If both scab and curculio were present but the total injury was no more than that due to a slight scabbing, it was graded as slightly marked by scab and curculio. If either or both were serious, the fruit was graded as seriously marked. There were too few in this group to make it worth while to distinguish between those badly scabbed and slightly marked by curculio, those slightly scabbed but badly marked by curculio and those seriously marred by both.

There was too little brown rot in the orchard to warrant keeping records of it.

The following table shows the results according to this classification:

GREENSBORO.

	Total No. of Peaches.	Clean.	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	277	275	0	0	2	0	0	0
Paste	785	739	2	0	38	6	0	0
Self-boiled	836	783	24	11	15	1	2	0
Atomic S.	369	289	43	15	13	7	2	0
Arsenate	582	259	168	88	21	19	13	14
		Percentages.						
Dust	.....	99.3	0	0	.7	0	0	0
Paste	.....	94.1	.3	0	4.8	.7	0	0
Self-boiled	.....	93.7	2.9	1.3	1.8	.1	.2	0
Atomic S.	.....	78.3	11.7	4.1	3.5	1.9	.5	0
Arsenate	.....	44.5	28.9	15.1	3.6	3.3	2.2	2.4

WADDELL.

	Total No. of Peaches.	Clean	Slightly Scabbed.	Badly Scabbed.	Slight Curculio.	Bad Curculio.	Slight Scab and Curculio.	Bad Scab and Curculio.
Dust	339	301	19	15	2	1	1	0
Paste	432	348	54	24	6	0	0	0
Self-boiled	699	239	195	253	7	0	5	0
Atomic S.	401	154	129	98	5	0	1	14
Arsenate	162	27	68	62	1	0	3	1
		Percentages.						
Dust	.....	88.8	5.6	4.4	.6	.3	.3	0
Paste	.....	80.6	12.5	5.5	1.4	0	0	0
Self-boiled	.....	34.2	27.9	36.2	1.0	0	.7	0
Atomic S.	.....	38.4	32.2	24.4	1.3	0	.2	3.5
Arsenate	.....	16.7	41.9	38.2	.7	0	1.8	.7
		MOUNTAIN ROSE.						
Dust	263	254	1	0	8	0	0	0
Paste	622	570	35	0	16	1	0	0
Self-boiled	859	699	98	27	25	8	2	0
Atomic S.	186	147	27	5	1	2	3	1
Arsenate	75	5	40	15	0	0	7	8
		Percentages.						
Dust	.....	96.6	.4	0	3.0	0	0	0
Paste	.....	91.6	5.6	0	2.6	.2	0	0
Self-boiled	.....	81.4	11.4	3.2	2.9	.9	.2	0
Atomic S.	.....	79.	14.5	2.7	.6	1.1	1.6	.5
Arsenate	.....	6.7	53.3	20.	0	0	9.3	10.7
		REEVES FAVORITE.						
Dust	49	40	4	0	4	1	0	0
Paste	53	45	3	1	2	2	0	0
Self-boiled	46	31	5	3	5	1	1	0
Atomic S.	189	108	47	6	20	5	2	1
Arsenate	25	5	10	4	0	0	2	4
		Percentages.						
Dust	.....	81.6	8.2	0	8.2	2.0	0	0
Paste	.....	84.9	5.6	1.9	3.8	3.8	0	0
Self-boiled	.....	67.3	10.9	6.5	10.9	2.2	2.2	0
Atomic S.	.....	57.1	24.9	3.2	10.6	2.6	1.1	5
Arsenate	.....	20.	40.	16.	0	0	8.0	16.0
		CARMAN.						
Dust	1331	1262	17	4	41	7	0	0
Paste	977	925	29	1	16	6	0	0
Self-boiled	977	826	96	32	10	12	1	0
Atomic S.	1282	924	268	60	20	7	1	2
Arsenate	1610	737	573	259	24	5	7	5
		Percentages.						
Dust	.....	94.8	1.3	.3	3.1	.5	0	0
Paste	.....	94.7	3.	.1	1.6	.6	0	0
Self-boiled	.....	84.6	9.9	3.2	1.0	1.2	.1	0
Atomic S.	.....	72.1	20.9	4.7	1.5	.5	.1	.2
Arsenate	.....	45.8	36.6	16.1	1.5	.3	.4	.3

The most striking feature of the tables is the almost perfect control secured by the use of the sulphur dust and paste applications against the scab, indicating plainly that these treatmens were far more efficient in the control of this trouble than the self-boiled lime-sulphur. It must

be borne in mind, however, that the lime-sulphur solution gave in every instance what could be considered a satisfactory control from a commercial viewpoint.

The slight advantage in the control of insect and fungous troubles was more than offset by the damage to the foliage of the trees treated with the dust and paste preparations. This was first noticed during the latter part of June when the leaves of these trees became covered with purplish spots, the centers of which soon fell out, causing an injury similar to that due to an attack by one of the peach leaf-spot fungi. By the first of July the condition of the trees was serious, many of the leaves had fallen and the injured leaves continued to fall during the months of July and August. The peaches from these trees ripened earlier than those on the uninjured trees and were of markedly inferior quality, being insipid and tasteless. The bearing capacity of the trees in 1915 cannot fail to be affected by this defoliation. The damage was greatest on the trees treated with the paste, and slightly less on the trees treated with the dust, due, perhaps, to the greater adhesion of the former preparation. The trees treated with atomic sulphur were similarly damaged, but to a considerably less extent. The foliage of the remaining two plots kept in good condition throughout the season.

As was to be expected, there was a considerable difference in the damage done to the different varieties. Carman was most seriously injured, Greensboro, Waddell, Reeves Favorite and Mountain Rose being successively less injured in the order named.

It has been suggested that, by combining the sulphur dust with air-slaked lime and the paste with milk of lime, the perfect control secured by the sulphur might be secured and at the same time the danger to the foliage eliminated. This is yet to be determined.

Experiments With Apples.

The apple experiments were conducted in the orchard of Mr. John H. Barclay, at Cranbury, a young and vigorous orchard of seven-year old trees which had received excellent care. The orchard contained several varieties, running fairly regularly across the plots, of which observations were taken on Yellow Transparent, Dutchess and Rome Beauty only. The object in these experiments, as in those with the peaches, was to test the efficacy of finely divided sulphur and arsenate of lead in controlling insect and fungus diseases as compared with the standard treatments. The insects which were injurious were the curculio, the codling moth and the apple aphis. The aphis was controlled by a separate spraying of Black Leaf 40, and does not enter into the records, while the damage done by the codling moth was insignificant. The only fungus disease of importance was the scab. This appeared in very slight degree on the Duchess, almost entirely upon the leaves, and in much greater degree on the Rome Beauty, where it attacked both the leaves and the fruit. As it happens, this is just the disease for which it is claimed the sulphur dust may be used to best advantage.

The part of the orchard used in the experiment was divided into five plots, each containing four rows of six trees, or a total of twenty-four trees

in each plot. The entire orchard received a thorough spraying with Scalecide and summer sprayings were planned as follows: (1) Cluster-cup stage; (2) at blossom fall; (3) ten days to two weeks after blossom fall; (4) four weeks after blossom fall, and (5) eight weeks after blossom fall. Plot 1 was used as a check plot, receiving powdered arsenate of lead at the rate of one and one-half pounds to fifty gallons of water. The final spraying was omitted on this plot. Plot 2 was sprayed with Pyrox at the rate of eight pounds to fifty gallons of water. Plot 3 received commercial lime-sulphur, one and one-quarter gallons to fifty gallons of water, to which was added in all but the last treatment one and one-half pounds of powdered arsenate of lead. Plots 4 and 5 were treated with finely divided sulphur containing ten per.cent. arsenate of lead. Plot 4 was sprayed with a solution or rather, suspension of this material at the rate of ten pounds to fifty gallons of water. On Plot 5 it was applied as a dust by means of an engine and blower similar to those used at Vineland.

Because the different varieties of trees in the plots blossomed and dropped their petals at different times, it was necessary to extend the earlier treatments over several days. Furthermore, as there were peach trees planted between the rows in all the plots, it was necessary to delay the lime-sulphur and Pyrox treatments until such times as there was no wind which would blow the spray upon the peach trees and cause injury to their foliage*. Finally the elbow and delivery tube belonging to the dust blower were not shipped with the machine and it was necessary to improvise them for the earlier treatments. The improvised elbow did not work satisfactorily, at times clogging and cutting down the flow of dust and at times wasting the material. For all of these reasons it was found impossible to keep a record of the cost of the materials.

The arsenate of lead used alone on Plot 1 did not spread satisfactorily and failed to protect the fruit from curculio injury. This was particularly severe on Yellow Transparent, nearly every apple being marked from one to several times. The Yellow Transparent on Plots 4 and 5 were also rather seriously injured, although to a lesser degree than those in Plot 1, while in Plots 2 and 3 the injury was very slight. The Dutchess apples were also marked less severely but about in the same proportions.

Scab began to develop on The Rome Beauty leaves early in August and became increasingly severe as the season progressed. For purposes of record, two trees in each plot were selected and all of the apples borne were carefully graded and counted. This count included the mature windfalls as well as the picked apples, although there were relatively few of the former. As will be seen by referring to Table I, the damage by curculio and codling moth was relatively insignificant on this variety and the record really resolves itself into one of scab control. For this purpose, the insect injury can be disregarded and all of the scabbed apples combined as in Table II. It should be said that all apples with from one to a few

*This precaution was not considered necessary in the case of plots 4 and 5, and the treatments were applied when there was sufficient wind to blow the material upon the peach leaves. The result was a defoliation of the peaches similar to that noted at Vineland.

spots not aggregating more than a square centimeter in area and not too conspicuously placed were classed as slightly scabbed, and any showing greater injury than this as badly scabbed. Table III gives the percentages of scab on the individual trees while in Table IV apples from both trees in each plot are combined and the percentages for the separate treatments computed.

It will be noted in the first place that the scab infection was not epidemic in the untreated plot, and in the second place that none of the treatments gave a complete control. The apples on the check plot were seriously enough injured to present a decidedly unsatisfactory appearance. Those treated with Pyrox were good except for a certain amount of copper injury, slight on the individual apples but enough to noticeably impair their general finish. The apples treated with the sulphur solution were small and poorly colored and the fact that these trees were somewhat more heavily laden with fruit than the others is hardly sufficient to account for the difference. On the other hand, there are no facts to demonstrate that this could have been in any way due to the form of the sulphur application. The apples treated with lime-sulphur and with the sulphur dust were alike noticeable for their superior finish and general excellent appearance.

The results seem to indicate that the sulphur dust treatment may be fairly comparable to the ordinary wet treatments so far as results are concerned under ordinary farm conditions. It is extremely probable that had the applications of the dust been determined very carefully by local weather conditions the control would have been much higher, but this was impracticable under the conditions in which it was conducted and is likely to be impracticable for the fruit growers, at least for some years to come. The chief advantage claimed for the sulphur equipment is its rapidity of application, permitting the grower, when weather conditions favorable to scab infection occur, to protect a much larger area of his orchard in a given time and with the same labor cost, than is possible with a wet spray. This advantage is of doubtful value under New Jersey conditions, while against it must be charged the greater cost of the material used and the necessity for maintaining a wet spraying apparatus in addition to the dusting machinery, for applying the dormant spray and for protection against the aphis when it occurs. We cannot yet feel warranted in recommending this material to New Jersey farmers.

Table I.

		Clean.	Slightly scabbed.	Badly scabbed.	Codling moth.	Codling moth and slightly scabbed.	Codling moth and badly scabbed.	Curculio injury.	Curculio and slightly scabbed.	Curculio and badly scabbed.	Number of apples on trees.
Check Plot.....	Tree 1.....	79	20	17	2	....	....	11	1	....	130
Check Plot.....	Tree 2.....	413	123	124	6	3	1	29	8	5	712
Pyrox Plot.....	Tree 1.....	514	34	40	....	....	....	13	1	1	603
Pyrox Plot.....	Tree 2.....	550	69	47	2	....	....	11	....	2	681
Lime-S. Plot.....	Tree 1.....	590	13	15	12	1	....	20	....	2	653
Lime-S. Plot.....	Tree 2.....	599	31	36	8	1	....	10	....	....	685
Sulphur Sol. Plot	Tree 1.....	658	49	70	6	....	....	23	1	....	807
Sulphur Sol. Plot	Tree 2.....	566	75	67	8	5	....	19	2	2	744
Sulphur Dust Plot ...	Tree 1.....	420	31	43	2	....	1	26	7	2	532
Sulphur Dust Plot ...	Tree 2.....	588	58	47	4	....	....	26	7	3	733
		4,977	503	506	50	10	2	188	27	17	6,280

Table II.

Classed with reference to scab only.

		Clean.	Slightly Scabbed.	Badly Scabbed.	Total.
Check Plot	Tree 1	92	21	17	130
Check Plot	Tree 2	448	134	130	712
Pyrox Plot	Tree 1	527	35	41	603
Pyrox Plot	Tree 2	563	69	49	681
Lime—S. Plot	Tree 1	622	14	17	653
Lime—S. Plot	Tree 2	617	32	36	685
Sulphur Sol. Plot	Tree 1	687	50	70	807
Sulphur Sol. Plot	Tree 2	593	82	69	744
Sulphur Dust Plot	Tree 1	448	38	46	532
Sulphur Dust Plot	Tree 2	618	65	50	733

Table III.

Percentages of scab—separate trees.

		Clean.	Slightly Scabbed.	Badly Scabbed.	Total.
Check Plot	Tree 1	70.8	16.1	13.1	100
Check Plot	Tree 2	62.9	18.8	18.3	100
Pyrox Plot	Tree 1	87.4	5.8	6.8	100
Pyrox Plot	Tree 2	82.7	10.1	7.2	100
Lime Sulphur Plot	Tree 1	95.3	2.1	2.6	100
Lime Sulphur Plot	Tree 2	90.1	4.7	5.2	100
Sulphur Sol. Plot	Tree 1	85.1	6.2	8.7	100
Sulphur Sol. Plot	Tree 2	79.7	11.0	9.3	100
Sulphur Dust Plot	Tree 1	84.2	7.1	8.7	100
Sulphur Dust Plot	Tree 2	84.3	8.9	6.8	100

Table IV.

Percentage of Scab—Combined.

	Clean.	Slightly scabbed.	Badly scabbed.	Total.
Check Plot	64.1	18.4	17.5	100
Pyrox Plot	84.9	8.1	7.0	100
Lime S. Plot	92.6	3.4	4.0	100
Sulphur Sol. Plot	82.5	8.5	9.0	100
Sulphur Dust Plot	84.3	8.1	7.6	100

Orchard Experiments With Pears.

The experiments with pears were of a preliminary nature only and were for the purpose of comparing the values of various standard sprays in maintaining the vigor of the foliage and increasing the quality of the fruit, while at the same time a general survey could be made to determine just what diseases are prevalent in the State and to what extent each demands treatment.

The following diseases have been particularly noted during the past season:

Blight (*Bacillus amylovorus* [Burr.] De Toni). This disease continues to be widespread and severe and is responsible for the fact that many of the better varieties, which are more susceptible to the disease, are now so little grown in the State, having been replaced by the relatively resistant Kieffer, in spite of the poor quality of the latter. No spraying treatment is at present expected to affect this disease.

Black Fruit and Leaf Spot (*Fabræa maculata* [Lev.] Atk.). This disease, associated with the *Entomosporium* stage of the fungus, is very common throughout the State and in some seasons causes serious losses by defoliating the trees and spotting the fruit. During the past season, it was not particularly serious in most localities.

Ashy Leaf Spot (*Mycosphærella sentina* [Fr.] Schr.). This, the so-called *Septoria* spot, occurred in several widely separate localities, and is probably of general distribution in the State, but seems to be nowhere serious.

Scab (*Venturia pyrina* Aderh.). This disease is exceedingly serious upon some varieties while others are nearly free from it. Kieffer is included in the latter group, while LeConte, Lawrence and Sheldon are sometimes almost completely covered with the velvety black growth of the fungus. When severe, it causes large cracks on the fruit and in the case of Le Conte and Lawrence pears it has been observed in such cases to be associated with pink rot (*Cephalothecium roseum* Cda.), while the fruit was still upon the tree.

Brown Blotch of Kieffer Pears (cause not known). This is perhaps the most serious trouble on Kieffer pears in New Jersey. It takes the form of irregular blotches, bright reddish brown in color and scattered irregularly over the surface of the fruit. The spots tend to coalesce, especially at the stem and blossom ends, and, while much of the injury is superficial, it spoils the appearance and sale of the pears, and it seems to injure the keeping qualities of the fruit so that affected pears shrivel up and rot much sooner than those which are not affected. It also appears to be more severe on small and poorly developed pears than on the larger ones. This may be because the epidermis of such fruits is so injured as to interfere with their development by failing to protect them from evaporation. This point, together with the actual cause of the trouble, is yet to be determined.

The disease is amenable to spray treatment, as will be indicated in the discussion of the experimental work.

There were other diseases present, among which may be mentioned black rot and crown gall, but these seem to have been of minor importance.

The principal experimental work was conducted in the orchard of Mr. E. L. Bolles at Vineland. This orchard contained 215 mature trees which had received cultivation and fertilizer, but were somewhat in need of pruning and in which the blight had not been cut out for some time. The entire orchard received a dormant spray of commercial lime-sulphur, 1-9, and arsenate of lead at blossom fall and for the summer treatments. It was divided into fifteen plots of approximately equal size. Eight of these were sprayed with Bordeaux mixture, two with Pyrox, two with Atomic sulphur, two with lime-sulphur and one was left unsprayed. The Bordeaux sprayings were planned to give indications as to the times at which spraying is of most value, while the other plots were planned as checks upon the Bordeaux sprayings. The only serious insect pests were the codling moth and the psylla. Arsenate was added to all of the earlier sprays except Pyrox for the control of the former and Black Leaf 40 to all the later sprayings in an attempt to control the latter. The attempt, it may be added, was only very partially successful. It is desirable that in any future experiment the orchards be secured and the plans made early in the season so as to permit the winter treatment of the psylla as recommended in Geneva Bulletin 387.

Inasmuch as the original plans were not completely carried out, it seems proper to substitute for them a list of the actual treatments given.

The Bordeaux used was made according to the 4-4-50 formula. The last lot, applied August 7th on Plots 1 and 7, was made with an inferior grade of lime and the resulting defoliation and severe spray injury on the fruit may be attributed to this cause. The lime-sulphur, testing 27 Beaume was used at the rate of seven and one-half pounds to 50 gallons, the Atomic sulphur at the rate of eight pounds to 50 gallons and the Pyrox at the rate of eight pounds to 50 gallons. The following list gives the detailed treatments:

Plot 1. Bordeaux—May 15, June 2, July 9, August 7.
Plot 2. Bordeaux—May 15, July 9.
Plot 3. Bordeaux—May 15, June 2, June 17, July 24.
Plot 4. Bordeaux—May 15, June 17.
Plot 5. Bordeaux—May 15, June 2, June 17, July 24.
Plot 6. Bordeaux—June 2, June 17.
Plot 7. Bordeaux—June 17, July 9, July 24, August 7.
Plot 8. Bordeaux—June 17, July 24.
Plot 9. Check—Arsenate only.
Plot 10. Lime-sulphur—May 15, June 2, July 9, August 6.
Plot 11. Lime-Sulphur—May 15, July 9.
Plot 12. Pyrox—May 15, June 2, July 9, August 6.
Plot 13. Lime-Sulphur—May 15. Atomic Sulphur—June 2, July 9, August 6.
Plot 14. Lime-Sulphur—May 15. Atomic Sulphur—July 9.
Plot 15. Pyrox—May 15. Atomic Sulphur—July 9.

The three most serious troubles in the orchard were the brown blotch, the black fruit and leaf spot and copper injury. The brown blotch was very severe on Plots 6, 9 and 11; severe on Plots 2, 3, 4, 10, 14 and 15; moderate on Plots 1, 8 and 13, and light on Plots 5, 7 and 12. Plot 6 received no spray after June 17; Plot 9, on which the trouble was most serious, was the check plot; Plot 11 received but two spray treatments with lime-sulphur. All of the plots on which good control was secured were sprayed four times with either Bordeaux or Pyrox, and the treatments continued to the end of July or the first part of August. Plots 10 and 13 both received late sprayings with lime-sulphur and atomic sulphur, which were not successful in either case in controlling this trouble. The indications are that a couple of treatments with Bordeaux, one the early part of July and one the first part of August, will control this disease.

Copper injury, in the form of enlarged and russeted lenticels, was severe on all of the Bordeaux plots, although less so on Plots 4 and 8, both of which received but two treatments, than on the others. It was relatively slight on Plot 12, sprayed with Pyrox, and absent from the other plots. Spray injury, taking the form of russeted fruits, was noticeable on the lime-sulphur plots and relatively slight on the others.

The black fruit and leaf spot was not severe anywhere in the orchard, although present to a considerable degree on both the fruit and leaves of Plot 9, the check plot, and Plot 11, sprayed twice with lime-sulphur. It appeared very late in the season on the leaves in Plots 14 and 15 and to a very slight extent in Plots 10 and 13. It did not occur in any of the Bordeaux plots, nor in Plot 12, given the full treatment with Pyrox.

To sum up, the results tend to show that, while Bordeaux mixture, when properly applied, will control both brown blotch and the black spot, its tendency to injure the fruit makes it desirable to weaken the mixture very much for the earlier applications, say to a 2-3-50 mixture, or to substitute lime-sulphur for these sprayings. The later applications could then be made stronger, if desired, although it is possible that the weak solution would be strong enough even for these. Further experiment is necessary to determine this point.

Cooperative experiments with the three principal sprays used—lime-sulphur, Pyrox and Bordeaux mixture—in the orchards of Mr. S. C. DeCou, Moorestown; Mr. W. H. Jones, Glassboro, and Mr. H. G. Taylor, Jr., Riverton, showed the lime-sulphur solution to be the most satisfactory of the three. In the DeCou orchard Pyrox gave the poorest results. In the Taylor orchard the mid-season treatments with Bordeaux caused such serious defoliation that the later treatments were omitted. No satisfactory explanation of this was found. There were no serious troubles in the Jones orchard—a young one, just coming into bearing—and there was, therefore, little difference between the various plots. Acknowledgements are due to all the growers mentioned for their interest and cooperation.

Owing to the sudden rise in the price of sugar coincident with the outbreak of war in Europe, the market for Kieffer pears was seriously affected, as many of them are taken by canneries under normal conditions, and these concerns could not use them while sugar remained high. For this

reason many growers are likely to feel that it is not profitable to spray this crop. These conditions, however, are merely temporary, and, in preparing for the future development of the fruit-growing industry in this State, it is highly important that we know very exactly just what spray treatments will be most advantageous to this important crop. Next year's experiments should test the suggestions resulting from this season's work and should also include as many varieties in addition to the Kieffer as is found practicable.

Jonathan Spot Rot.[1]

MEL. T. COOK and G. W. MARTIN.

This very troublesome rot disease of the Jonathan, and of some other apples, has been under observation for the past three years. The spots appear, frequently in great abundance, in or soon after the fruit comes from cold storage and greatly reduce the market value. They may also occur on mature fruit in the orchard, especially if picked late. The spots are small, seldom more than 1 cm. in diameter, usually circular. brownish or black in color and slightly sunken. A lenticel in the center of the spot indicates that the infection may be through that point. Irregularly shaped spots of the same character are also found about minute fruit cracks. The diseased tissue is dry, shallow, and can be readily separated from the underlying healthy tissue. The spot can be readily distinguished from the Baldwin spot and the New Hampshire fruit spot. The writers have found this same spot on Nero, Smokehouse and Newtown Pippin. Scott and Roberts report the same spot on Esopus (Spitzenberg), Yellow Newton, Grimes Golden and Arkansas Black. Stakman and Rose report this or a similar disease as serious on Wealthy, Wolf River and Peter, and occurring on Peerless, Red Mirror, Hibernal and Patten's Greening in Minnesota.

A large number of cultures prepared by the writers gave more than 90 per cent. *Alternaria*. Stackman and Rose found 70 per cent. of all spots infected with *Alternaria*. However, the fact that *Alternarias* are so common on decaying vegetable matter has led to some doubt with us and other workers as to whether the spot is caused by this organism, or initiated by some other cause and later infected by the *Alternaria*.

Scott and Roberts are inclined to believe that the spot is purely physiological and the infection secondary. They say that "Nearly 400 cultures of the disease spots have been made in various ways and on various media, but no organism has been isolated with any degree of consistency. A species of *Alternaria* often occurred in cultures from fruit grown in the eastern part of the country, but cultures from northwestern-grown fruit were almost entirely barren. A few apparently successful inoculations were made by spraying *Alternaria* spores on Jonathans kept in moist chambers and the fungus re-isolated, but both Jonathan and Esopus (Spitzenberg) are so susceptible to the disease than they are apt to become spotted under any conditions outside of cold storage. In some cases both the inoculated fruit and the controls contracted the disease at about the same time. Spores of this fungus inserted through needle punc-

[1]The following papers on this disease have been published:
Mel. T. Cook and G. W. Martin—Phytopathology 3: 119–120 (1913).
Mel. T. Cook and G. W. Martin—Phytopathology 4: 102–105 (1914).
G. W. Martin—Phytopathology 5: (1915).
Scott, W. M. and Roberts, J. W.—U. S. Dept. of Agriculture, Bureau of plant Industry Circular 112: 11–16 (1913).
Norton, J. B. S.—Phytopathology 3: 99–100 (1913).
Stakman, E. C. and Rose, R. C.—Phytopathology 4: 333–336 (1914).

tures failed to produce the disease. As *Alternaria* is very commonly associated with rotting apples, especially when the fruit is placed in cellar or basement storage, the possibility of its being the cause of this disease becomes very remote."

Norton calls attention to experiments in which he produced a spotting on Jonathans and other varieties by exposing them to formaldehyde and ammonia gas. He calls attention to the fact that "Some badly pitted apples from cold storage had a very conspicuous ammonia-like odor in their paper wrappings, which suggested the idea that ammonia from the cooling apparatus might be a common cause of the Jonathan spot."

In 1913 we bagged a large number of apples at intervals throughout the growing season, believing that, if the disease was due to an *Alternaria*, we could protect the fruit from infection and thus produce clean apples, while, if due to physiological causes, the apples in the bags would develop the spots the same as those that were unprotected. The trees were sprayed with lime-sulphur for scale before the opening of the buds, again for scab before the opening of the flower buds and again for scab and codling moth after the falling of the petals. The first bagging followed this spraying and therefore these fruits received no other treatments. Some of the fruit which was bagged later in the season received the regular additional summer treatments with self-boiled lime-sulphur. The bags were made of "glassine" paper which was semi-transparent or translucent and slightly water proof. These were fastened by first wrapping cotton about the twig above the fruit and then tying the neck of the bag firmly at this point. This prevented injury to the twig and the entrance of spores from the outside. No attempt was made to sterilize the fruit or twigs before covering them with the bags, and, of course, it is recognized that some spores were probably inclosed with the fruit. This first lot of about three hundred apples was bagged on May 9 and lots of two to four dozen were bagged at frequent intervals thereafter until August 15. A very large number of those bagged early in the season dropped from natural causes; while in the case of those remaining, as well as of those bagged later in the year, so many of the bags were injured by hail and rain storms that it is not possible to announce any definite conclusions. The fruit was picked October 3; part put in cold storage and part brought directly into the laboratory for immediate observation. Records were made November 13, 1913, and January 8, 1914. Although the loss of apples due to storms was so great that we hesitate to draw conclusions, a few statements can be made.

It will be noted that the bagged apples were in far better condition than those that were not bagged. This may be considered a fair representation of the results obtained. If the spot is physiological, it appears that we might reasonably expect approximately as much spotting on the fruit in the bags as on that not in bags. On the other hand, the fact that we did not disinfect fruit or twigs before bagging makes it possible that some spores were imprisoned in the bags and were the cause of the spotting.

1. The number of spots on apples bagged previous to June 9 was much less than on those bagged after that date.

2. The relative injuries due to spotting may be expressed in the following incomplete table:

Date of Examination.		Apples without spots.	Apples with few spots.*	Apples with many spots.
November 13, 1913	Bagged apples	72	18	10
November 28, 1913	Bagged apples	42	39	19
January 8, 1914 (Part of same fruit as inspected November 13, 1913).	Unbagged apples	21	47	32

* Apples with ten or less spots.

3. The smaller, nearly black, typical "Jonathan" spots are commonly confined to the dark area of the skin.

4. The rather large, light-brown "Alternaria" spots are more common on the lighter area of the skin.

5. There are spots occurring on any area which are hard to classify as one one or the other of the above and which grade into one or the other. These are not so common as the clearly distinguishable spts.

6. Many of the "Jonathan" spots are surrounded by a light-brown area characteristic of the "Alternaria" spots.

The orchard experiments were continued in 1914 but, owing to the pressure of other work, these investigations were not as extensive as hoped for early in the season. The number of spots on apples bagged previous to June 9, 1913, was much less than on those bagged later in the season. Therefore, it was decided to bag only two lots of apples in 1914, one lot shortly before June 9th and one lot about two months later. Accordingly, 200 apples were bagged on June 5th and 6th and a little more than 100 on August 14th. The method was the same as that used in 1913. The bagged apples were picked on October 5th and 6th and, without removing them from the bags, they were placed in ordinary peach baskets and stored in a cool cellar until November 12th, when they were examined and sorted into three grades: clean, slightly spotted and badly spotted. The grading was somewhat more critical than that of 1913; apples with from one to five spots, aggregating not more than one square centimeter in area and not conspicuously placed being classed as slightly spotted, while anything more caused an apple to be classed as badly spotted. At the same time 200 No. 1, unbagged apples from the same trees were examined and classified as a check. However, the check had been stored in a different cellar under somewhat more favorable conditions than the bagged fruit, in that the temperature was slightly lower and more constant than in the cellar in which the bagged apples were stored. The results were as follows:

	Clean.	Slightly Spotted.	Badly Spotted.	Total.
Bagged June 5 and 6	58	25	27	110
Bagged Aug. 14	39	31	31	101
Not bagged	73	57	70	200

NOTE: The totals are not equal to the number bagged. This is due to the fact that certain fruits dropped from the stem, rotted or were otherwise destroyed after bagging.

PERCENTAGE TABLE.

	Clean.	Slightly spotted.	Badly spotted.
Bagged June 5 and 6.	52.7	22.7	24.6
Bagged Aug. 14.	38.6	30.7	30.7
Not bagged	36.5	28.5	35.

The percentage of apples bagged June 5 and 6 which are free from rot is not so high as is the general percentage of bagged apples in 1913, but it is considerably higher than for the apples bagged August 14th and for the check. The percentage of clean fruit from those bagged August 14th is very little higher than for the check.

Although these figures are not conclusive, they tend to confirm our previously expressed opinion that the *Alternaria* is an important factor in the Jonathan spot.

A Nectria Parasitic on Norway Maple.

By MEL. T. COOK.

During the summer of 1913 the writer's attention was called to an interteresting disease on a group of Norway maples growing on the private grounds of one of the residents of Princeton, New Jersey. The first symptoms of the disease were the wilting of the leaves and dying of branches very similar to the well known symptoms of the chestnut bark blight disease *(Endothia parasitica)*. In fact, it was the very striking resemblance to the chestnut blight that attracted the attention of the Superintendent of the grounds and lead to the writer's being called to make an examination. A further examination of the dead branches showed a still more marked resemblance to the chestnut bark blight; the dead branches had been completely girdled by a canker which caused a blackening and slight sinking of the diseased bark. The old cankers were covered with the orange colored pustules of the tubercularia stage of a Nectria and there was abundant evidence that this organism was the cause of the trouble.

The Superintendent had been watching the disease for some time and had removed many dead branches and cankers. Fresh wounds were very quickly attacked by the fungus, which made its first growth in the oozing sap, but the careful treatment of these wounds with antiseptics, followed by an application of paint, greatly reduced the number of infections. The breaking of the small lateral twigs from the trunk and larger branches was the most common source of natural infections and most of the cankers had started from wounds of this kind.

An inspection of the trees on the estate and in the immediate vicinity showed two others badly affected. These were destroyed, but the clump previously referred to were left standing for observation and study. During the remainder of 1913 the infected parts were removed as soon as detected and the wounds treated. In the fall of 1913 and the spring of 1914 heavy applications of fertilizers were applied to all the trees and observations continued during the sumber of 1914. The disease reappeared and the fungus was always present on the cankers but was much less severe than in 1913. The fungus was frequently found in the dead bark around old wounds, but in many cases did not appear to be parasitic. About one-third of the trees in this clump showed the fungus in 1914. Another clump of trees on the opposite side of the driveway showed but very little of the fungus. The fungus was afterwards found on the Norway maples in a nursery at Nutley, N. J., but, so far as the writer could determine, it was saprophytic or only feebly parasitic.

Specimens of the fungus were sent to Dr. C. L. Shear, who confirmed the writer's diagnosis that it was the Tubercularia stage of a *Nectria*, probably *N. cinnabarria* or *N. coccinea*.

91
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REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
OCTOBER 31, 1915

PATERSON, N. J.
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13

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

*GEORGE W. MARTIN, M.SC., *Assistant in Plant Pathology.*

†WILLIAM H. MARTIN, A.B., *Research Assistant.*

‡WEBSTER S. KROUT, M.SC., *Research Assistant.*

*Resigned October 1, 1915.
†Appointed July 1, 1915.
‡Appointed August 1, 1915.

CONTENTS

	PAGE
I INTRODUCTORY	365
II MOST COMMON DISEASES OF THE YEAR	367
III REPORT OF POTATO SCAB EXPERIMENTS, 1915	375
IV REPORT OF POTATO SPRAYING EXPERIMENTS FOR 1915	381

Report of the Department of Plant Pathology

I.

INTRODUCTORY.

The organization of the Department has been slightly changed since our last report. Mr. G. W. Martin resigned October 1, 1915 and Mr. W. H. Martin, A. B. of the University of Maine and Mr. W. S. Krout, M. S. of the Ohio State University have been appointed assistants. The former began work July first and the latter August first. Mr. H. Clay Lint, M. S. of the Kansas Agricultural College continues in the Fellowship in Plant Pathology, supported by the Union Sulfur Company, for the study of potato scab. Mr. C. A. Schwarze, M. S. of the Columbia University continues with us as Assistant State Plant Pathologist and Mr. Edgar L. Dickerson, B. S. of Rutgers College was employed as special Assistant State Plant Pathologist during July and August to assist in the nursery inspection work.

CLIMATIC CONDITIONS.—The season of 1915 will be remembered as one in which we had heavy rainfalls from early in the spring until late in the summer. This exceptionally wet weather resulted in a very large number of fungus diseases on the agricultural crops, and increased the number of demands for personal visitation to the farms for the purpose of giving advice, and also increased the amount of correspondence. It was impossible to respond to all the calls for assistance.

COOPERATION.—Experiments and studies on the brown blotch and black spot of the pear were conducted on the farms of Mr. E. L. Boles, Vineland, Mr. W. H. Jones, Glassboro; and Mr. Wm. H. Titus, Titusville, by Mr. G. W. Martin. The results of these experiments have been published in circular No. 52.

Experiments for the control of the potato scab were conducted on the farms of Mr. Walter Minch, Bridgeton; Mr. Jos. H. Fogg, Bridgeton; Mr. Hartley Ridgeway, Bridgeton; Mr. M. F. Riley, Elmer; Mr. W. J. MacFarland, Burlington; Mr. Earle Dilatush, Robbinsville; Mr. J. Carroll Burtis; Allentown; and Mr. C. W. Stevens, Jr., New Brunswick, by Mr. H. Clay Lint and supported by the Union Sulfur Company. The results of these experiments are appended to this report (page 375).

Spraying experiments in cooperation with the Department of Entomology, and under the direction of Mr. H. Clay Lint were con-

ducted on the farms of Mr. J. Harry Kandle, Elmer; Mr. John W. Black, Mt. Holly; and Mr. Frank P. Jones, Freehold, the results of which are appended to this report. Additional spraying experiments by this Department were conducted on the farm of Mr. Courtney Brown of Jamesburg, and the results are incorporated with the above spray experiments on potatoes (page 381).

Spraying experiments for the control of Black Rot of the grape were conducted by the writer on the farm of Dr. T. Franklin Gifford at Glassboro, the results of which have been published in circular No. 55.

PLANS FOR 1916.—The following outline of field experiments for 1916 is proposed:

1. **A continuation of the experiments for the control of potato scab by the use of sulfur, by H. Clay Lint.**
2. **A continuation of the potato spraying experiments, by H. Clay Lint.**
3. **Studies on the diseases of the tomato and experiments for their control, by W. H. Martin.**
4. **Studies of the diseases of celery and methods for their control, by W. S. Krout.**

NURSERY INSPECTION.—All the nurseries of the State have been inspected in accordance with Chapter 54, Laws of 1911. They were exceptionally free from fungus and bacterial diseases. The nurserymen are much more interested in these diseases than they have been at any time in the past and many of them are taking every possible precaution for the control of these pests.

The shipments of nursery stock into this State have been much larger than usual and it has been impossible to inspect any considerable amount. However, the work was carried forward as thoroughly as time and funds would permit. It was found necessary to destroy stock in but very few cases.

In our last two reports, we called attention to our cooperation with the Department of Horticulture for the control of Peach Yellows by the distribution of peach buds to the nurserymen in the State who wished to make use of them. The increased demands upon the time of the workers in both this and the Department of Horticulture made it necessary to discontinue this work this year.

EPIDEMICS.—There were four very pronounced epidemics this year. The first was the Fire Blight of the pear and apple which was very destructive throughout the southern half of the State. The second was the Rhizoctonia of the potato which was the cause of poor stand and reduced yields. A special paper on this disease is appended to this report. The third was the Mosaic of the tomato which was very severe in many localities of the State and was also the cause of heavy losses. Fourth, the anthracnose of beans was also much more severe than in the past years and was the cause of heavy losses.

PUBLICATIONS—The following publications have been issued during the year: Circular 44, "Common Disease of Apples, Pears, and

Quinces." Circular 45, "Common Diseases of Peaches, Plums and Cherries." Circular 48, "Bordeaux Mixture."

NEEDS.—The demands of the farmers for personal inspection and advice in regard to a number of diseases, and the very heavy correspondence, emphasize the necessity of having another man in the Department who will devote the greater part of his time to this work, and also to the direction of demonstrations in spraying and other methods of treatment of plant diseases. The increase in the number of county demonstrators is increasing the demand for a man to do this kind of work. During the past year the writer has been compelled to refuse to visit a number of those who requested advice.

The very great importance of the potato industry in New Jersey makes it urgent that there should be at least one man, not necessarily connected with this Department, to make studies on varieties best suited to the State, character of the seed, treatments for diseases and many other problems which are constantly arising in connection with this industry.

The Department is also in need of a plot of ground and a greenhouse specially constructed for experimental work with diseases of plants. At present many experiments and studies are impossible, while the few that we are able to undertake must be conducted on the charity of other departments, at great inconvenience to all parties concerned, and with reduced efficiency.

There is an urgent demand for investigation in a number of diseases which are proving very destructive every year. Among the most important are the Fusarium wilt of the tomato, the Mosaic of the tomato and the Septoria leaf blight of the tomato; the root rot of celery, leaf blight of celery; the wilt disease of egg plant; the wilt and blight diseases of melons and cucumbers; the root disease of alfalfa, the leaf spot of alfalfa; a root disease of coniferous trees; and numerous diseases of ornamental plants. The growing of ornamental plants in New Jersey is one of the most important industries, and the inquiries concerning the diseases of these plants are becoming more and more numerous. These problems are worthy of a very careful study.

II.

MOST COMMON DISEASES OF THE YEAR.

The following is a list of diseases which have been reported or collected by members of the staff during the year. More than half of these diseases were sent in by farmers with inquiries as to their character and methods of control. In some cases there were a great many inquiries concerning a disease.

Alfalfa.

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease has been about the same as in past years. There were several inquiries concerning it, and it is no doubt the cause of rather heavy losses due to the dropping of the leaves.

WHITE SPOT (Undetermined). Prevalent but not causing a falling of the leaves.

LEAF SPOTS (*Pleospora sp., Cercospora medicaginis* E. & E. *Phyllosticta sp.* and *Ascochyta* sp.) are occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes were sent in from time to time.

ROOT ROTS (*Rhizoctonia* sp.). This organism was found in two plantings. Reports indicated that this or some other root rot organism was causing considerable damage in other localities.

Ampelopsis.

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

DIE BACK (*Cladosporium sp.*). This disease occurs on the *A. tricuspidata.* It was much less severe than in 1914. This was probably due to the fact that in 1914 we had a very dry season and in 1915 a very wet season.

Apple.

JONATHAN SPOT (*Alternaria sp.*) A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be about equally severe from year to year.

Other similar spots are no doubt due to other causes.

BLOSSOM END ROT (*Alternaria sp.*). This disease continues to cause a great deal of trouble with many varieties. It has been less prevalent than in 1914.

ANTHRACNOSE, OR BITTER ROT (*Glomerella rufomaculans* [Berk.] S. & Von S.). Several records. More common than usual.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). This outbreak occurred soon after blossoming and was very destructive. Much of it was due to blossom infection which later spread to the young fruits. There was also an abundance of twig blight, and many orchards looked as though they had been swept by fire. In many localities large trees were killed by the disease. It was most severe in the southern half of the State.

BLOTCH (*Phyllosticta solitaria* E. & E.) (Fig. 1). This disease has been very severe on some varieties, especially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* [Schw.] Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This was less severe than usual.

BROWN ROT (*Sclerotinia fructigena* (?) [Per] Schroet). More than usual.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphaeropsis malorum* Pk.). Common, but not so severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the State. (*G. globosum* Farl.). Occasional.

MILDEW (*Podosphaera oxyacanthae* [De C.] De Bary). One record.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith & Townsend). This very common disease is receiving more attention from both nurserymen and growers.

WATER CORE. Occasional.

SPRAY INJURY was much more common than for many years. Spray mixture which had not previously resulted in injury proved very injurious although applied by men thoroughly familiar with the business.

WINTER INJURY was less common than for several years.

LEAF SPOT (*Coryneum foliicolum* Fckl.). In 1912 we reported one case of this disease but later studies indicate that this was an error.

LEAF SPOT AND FRUIT ROT (*Monochaeta* sp.). Occasional.

Asparagus.

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

ROOT ROT (*Rhizoctonia sp.*). This organism was found to be very destructive in one planting and reports indicate that it may be prevalent in other places.

Aster.

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. It was much more severe on outdoor than on indoor plants.

ROOT ROT (*Fusarium sp.*). Several reports.

Barley.

SMUT (*Ustilago nuda* [Jens.] Kell. & Sw.). Very common and in some cases very abundant.

MILDEW (*Erysiphe graminis* D. C.). One very severe outbreak on one of the College Farm experiments.

Bean.

ANTHRACNOSE (*Colletotrichum lindemuthianum* [Sacc. & Magn.] Bri. & Cav.). This disease was much more abundant than in past years and was the cause of many complaints. Its prevalence was, no doubt, due to the rainy season.

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.
RUST (*Uromyces appendiculatus* [Pers.] Lev.). One record.
POD SPOT (*Phoma subcircinata* E. & E.). This disease was very common on lima beans.
DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Common on the lima bean.
ROOT ROT (*Rhizoctonia* sp.). Investigations of several complaints showed that this organism was present in cankers on the stems. It was frequently associated with *C. lindemuthianum*.

Beet.

LEAF BLIGHT (*Cercospora beticola* (Sacc.). Quite common.

Blackberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common, and destructive in many places.
LEAF SPOT (*Septoria rubi* West.). Common.
RUST (*Gymnoconia peckiana* [Howe] Tranz.). Common, and the subject of many inquiries.

Cabbage, Cauliflower and Kohlrabi.

CLUB ROOT (*Plasmodiophora brassicae* Wor.). This disease was reported from many localities, but most frequent from the northern part of the State.
LEAF MOULD (*Macrosporium brassicae* Berk.). One report.

Cantaloup.

See Muskmelon.

Carnation.

RUST (*Uromyces caryophyllinus* [Schrank] Wint.). Common but not serious.
ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.
BUD ROT (*Sporotrichum poae* Pk.). One record.
YELLOWS (?). Serious on some varieties.

Catalpa.

LEAF SPOT (*Marcrosporium catalpae* Ell. & Mart.). Common.
LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common.

Cedar.

RUST (*Gymnosporangium juniperi-virginianae Schw.*) (*Gymonsporangium germinale* [Schw.] Kern.). Reported but of little importance. The former was most abundant in Cape May County. *G. botryapites* was found to be quite abundant in Atlantic County.

Celery.

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.
LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.) Very abundant in certain localities and one of the most important celery diseases in the State.
ROT (Bacterial [?]). Very severe in many localities.

Chard.

LEAF SPOT (*Cercospora sp.*). One record.

Cherry.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common, and the subject of many complaints.

Chestnut.

BARK DISEASE (*Endothia parasitica* [Mur.] Ander.). Common throughout the State.
LEAF SPOT (*Actinopelte japonica* Sacc.). One record.
LEAF SPOT (*Marssonia orchroleuca* B. & C.). One record.

Citron.

LEAF SPOT (*Cercospora citrullina* Cke.). Common.

Crimson Clover.

CROWN ROT (*Sclerotinia libertiana* Fuckel.). Not as common as usual.

Red Clover.

RUST (*Uromyces trifolii* [Hedw.] Lev.). Occurs throughout the State.
LEAF SPOT (*Cercospora medicaginis* E. & E.). One record.
LEAF SPOT (*Pseudopeziza trifolii* [Beruh] Fd.). One record.
ANTHRACNOSE (*Colletotrichum trifolii* Bain). One record.

Sweet Clover.

STEM SPOT (*Ascochyta caulicola* Loubert). One record.

Corn.

SMUT (*Ustilago zeae* [Beckm.] Ung.). This very common and very widely distributed disease is not often serious except on sweet corn.

WILT (*Pseudomonas stewarti* Erw. Smith). This disease was reported from several localities in the early part of the season, and was the cause of considerable loss among growers of early sweet corn.

RUST (*Puccinia sorghii* Schw.). Not serious.

Cowpea.

LEAF SPOT (*Cercospora dolichii* E. & E.). Frequent.

Crab (Flowering).

RUST (*Gymnosporangium*, probably *G. juniperi virginianae* Schw.). Occasional.

BLACK ROT (*Sphaeroosis malorum* Pk.). One record.

Cranberry.

SCALD (*Guignardia vaccinii* Shear). This disease was widely distributed throughout the State, and the cause of considerable loss where the bogs were not well sprayed.

GALL (*Synchytrium vaccinii* Thomas). Very abundant in one bog.

FALSE BLOSSOM (Cause undetermined). Prevalent in one part of one bog. Said to have been introduced on plants from Wisconsin.

Croton.

LEAF SPOT (*Gloeosporium* sp.). In greenhouse—One report.

Cucumber.

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed, and the cause of considerable loss.

DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common, and frequently the cause of heavy losses.

Dahlia.

LEAF SPOT (*Phyllosticta* sp.). Common.

Dewberry.

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand picking of the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Very abundant, and in some cases destructive.

LEAF SPOT (*Septoria rubi* West). Common.

RUST (*Gymnoconia peckiana* [Howe.] Tranz.). Reported as common, and in some cases destructive.

Dracaena terminalis.

LEAF SPOT (*Phyllosticta maculicola* Hals.). In green-houses.

Egg Plant.

LEAF BLIGHT (*Phomopsis vexans* [*Sacc.* & *Syd.*] Harter; Syn. *Phyllosticta hortorum* Speg.). Very common and in some cases destructive.

WILT (*Fusarium* sp.). Common and destructive.

Elm.

LEAF SPOT (*Melasmia* stage of *Rhytisma* ulmi Fr.). Very common.

Euonymus.

MILDEW (*Microsphaera euonymi* [D. C.] Sacc.). One record.

Gladiolus (Gladiolus sp.)

BULB ROT. Cause undetermined.

Grape.

BLACK ROT (*Guignardia bidwellii* [Ell.] Viala & Ravaz). (Fig. 2). Common and very destructive in some vineyards in the southern part of the State.

ANTHRACNOSE OR BIRD'S EYE ROT (*Gloeosporium ampelophagum* Sacc.). One record.

RIPE ROT (*Gloeosporium fructigenum* Berk.). One record.

NECROSIS (*Fusicoccum viticolum* Reddick). Two reports.

DOWNY MILDEW (*Plasmopara viticola* [B. & C.] D. T.). Common but not serious.

BITTER ROT (*Melanconium fuligineum* S. & V. Cav.). One record.

Hawthorne (English).

BERRY SPOT (*Phyllosticta* sp.). One record.

Hollyhock.

RUST (*Puccinia malvacearum* Mont.). (Fig. 3). Very common, and the subject of many inquiries.

Horse-Chestnut.

LEAF BLOTCH (*Phyllosticta paviae* Desm.). Less severe than usual.

Horse Radish.

LEAF SPOT (*Septoria lactucae* Pass.). One record.

Juniper.

RUST OR CEDAR APPLE. See Apple.

Kohlrabi.

CLUB ROOT (*Plasmodiophora brassicae* Wor.). Common.

Lettuce.

LEAF SPOT (*Septoria lactucae* Pass.). One record.

Lilac.

MILDEW (*Microsphaera alni* [Wallr.] Wint.). Abundant throughout the State.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple.

DARK DISEASE (*Nectria coccinea* or *N. cinnabarina* [Tode.] Fr.). The *Tubercularia* stage of *Nectria* was found on Norway maples, evidently working as a weak parasite.
TAR SPOT (*Rhytisma acerinum* [P.] Fr.). Occasional.
LEAF SPOT (*Phyllosticta acericola* C. & E.). Common.
ANTHRACNOSE (*Gloeosporium apocryptum* E. & E.). Several records.
LEAF SCALD (Physiological). Many complaints.
WINTER INJURY. Occasional.

Mignonette.

LEAF SPOT (*Cercospora resedae* Fckl.). One record.

Mulberry.

DIE BACK (*Sphaeropsis mori* Berl.). One record.
DARK DISEASE (*Nectria* sp.). One record. Evidently working as a weak parasite.

Muskmelon.

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith.). Common and destructive in some cases.
DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common but not severe.
MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common.

Oak.

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). The *Gloeosporium* stage was common and the cause of many complaints.
MILDEW. Conidial stage. Occasional.

Nasturtium.

LEAF SPOT (*Bacterium aptatum* B. & J.). One record.

Oats.

SMUT (*Ustilago avenae* [Pers.] Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia graminis* Pers.). Occasional. (In the Report of the Plant Pathologist of the New Jersey Station for 1913, it was stated that this was common. This was an error.)

Onion.

ROT (*Bacterial?*) Several reports. Probably influenced by the wet weather.

Okra.

WILT (*Verticillium* sp.). Abundant in one locality and found in another.

Pea.

STEM AND ROOT ROT (Apparently due to *Fusarium* sp.). Quite common, and destructive in some localities.
LEAF SPOT (*Ascochyta pisi* Lib.). Two records.

Peach.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.) (Fig. 4). Common throughout the State. Severe on fruit in unsprayed orchards. Also the cause of more dying back on the new growths than usual.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Common. See Apple.
LEAF CURL (*Exoascus deformans* [Berk.] Fuckel.). Abundant where the orchards were not sprayed.

SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of the spraying. In most cases it developed much later than usual, an indication which led many growers to believe that it would not be a serious pest.

SHOT HOLE (*Phyllosticta circumcissa* Cooke). Common.

SHOT HOLE (*Bacterium pruni* Smith). Less severe than for the past two years.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Occasional.

YELLOWS AND LITTLE PEACH. Very abundant and the cause of heavy losses.

WINTER INJURY. Several reports.

SPRAY INJURY. Several reports.

Pear.

BROWN ROT (*Sclerotinia fructigena* (?) [Pers.] Schroet). More abundant than usual.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). Common. See Apple.

LEAF BLIGHT (*Fabraea maculata* Lev.—Entomosporium stage). Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH. (Cause?). Common in southern part of the State. (Figs. 5, 6, 7.)

Peony.

BUD ROT (Cause undetermined). Prevalent.

Pepper.

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in the fall.

ROT (*Macrosporium* sp.). Common on fruits and also found on seeds. May have been secondary.

Pine.

ROOT DISEASE. This disease is evidently due to the attack of a root fungus resulting in a Mycorhiza. It is very destructive in the nurseries on pines and other coniferous stock grown under crowded conditions.

RUST (*Peridermium piriforme* Pk.). Common in Atlantic County and probably has a wider distribution. The *Cronartium* or *Comptoniae* was also collected in Atlantic County.

(*P. acicolum* collected on *P. taeda*). Common in Atlantic County.

(*P. pini*) was also collected in Atlantic County on *Pinus taeda*.

Plum.

BLACK KNOT (*Plowrightia morbosa* [Schw.] Thum.). Common throughout the State.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the State. See Peach.

SHOT HOLE (*Phyllosticta circumscissa*). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

Poplar.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Occasional.

LEAF SPOT (*Marsonia populi* [Lib.] Sacc.). Common.

Potato.

SCURF (*Rhisoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This very widely distributed disease was much more severe this year than usual. A special paper on this disease is appended to this report.

BLACK LEG (*Bacillus phytophthorus* Appel). This well-known disease was less severe than usual.

SCABS. (*Actinomyces chromogenus* Gasp.). This disease was fully as severe as in past years.

RUSSET SCAB. A peculiar russetting was common in many parts of the State. It appears that this condition can be produced by the common scab organism or by *Rhisoctonia*.

SILVER SCURF (*Spondylocladium atrovirens* Harz.). This newly introduced European disease was found in a few fields. It is very doubtful if it will prove serious on our New Jersey crop.

EARLY BLIGHT (*Alternaria solani* [E. & M.] S. & G.). This disease was more abundant, but it cannot be said to be of much importance in the New Jersey crop.

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was more abundant on the growing crop than usual.

ARSENICAL POISONING was reported from a few localities. It was always due to careless treatment.

TIP BURN. The season was much wetter than usual and the potatoes ripened at least two weeks earlier than usual. This early ripening was apparently due to tip burn caused by intense heat on rather succulent plants growing with a superabundance of water, but was complicated to some extent by fungus diseases, especially by the prevalence of *Rhisoctonia*,

NET NECROSIS (Cause undetermined). Much more abundant than usual.
ROLL LEAF (Cause unknown). This disease was quite prevalent in many localities.
MOSAIC (Cause unknown). Prevalent in some fields.
CURLY DWARF (Cause unknown). Occasional.
DODDER (*Cuscuta* sp.). Occasional.

Phlox.

POWDERY MILDEW (*Erysiphe communis* [Walh] Schl.). Common.

Privet.

ANTHRACNOSE (*Gloeosporium cingulatum* [Atk.] S. & S.). One record.

Quince.

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe. See Apple.
FIRE BLIGHT (*Bacillus amylovorus* [Burr.] DeToni). Abundant and severe. See Apple.
RUST (*Roestellia aurentiana* Peck). Reported from several localities.

Raspberry.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Abundant and destructive.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. See Apple.
LEAF SPOT (*Septoria rubi* West). Abundant.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Abundant and destructive. The cause of an increasing number of complaints.
CANE SPOT (*Cytospora rubi* Schw.). One record.
CANE SPOT (*Rhabdospora rubi* Ellis). One record.

Rose.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Frequent.
ANTHRACNOSE (*Gloeosporium rosae* Hals.). Common, but no serious.
LEAF BLOTCH (*Actionema rosae* [Lib.] Fr.). Common, and very severe in the greenhouses.
POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Common and more severe than usual.
RUST (*Phragmidium subcorticum* [Schr.] Went.). One record.
LEAF SPOT (*Phyllosticta rosicola* Mass.). Abundant, and frequently confused with black spot.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common, and the cause of many complaints.

Screw Pine (Pandanus utilis).

LEAF SPOT (*Phomopsis sp.*). In greenhouses. Does considerable damage.

Snap-Dragon.

ANTHRACNOSE (*Colletotrichum antirrhini* Stew.). One record.

Strawberry.

LEAF SPOT (*Mycosphaerella fragariae* [Tul.] Lindau). Common.
LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.
LEAF SPOT (*Marsonia potentillae* [Desm.] Fish). Frequent.
WINTER INJURY. Reported from several localities.

Sweet Potato.

BLACK ROT (*Sphaeronema fimbriatum* [E. & H.] Sacc.). Abundant, but not so severe as in 1912.
WET ROT (*Rhizopus nigricans* Ehr.). Common in storage, but readily controlled by ventilation.
STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen.). Common, but not so destructive as in 1912.
ROT (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.
CHARCOAL ROT (*Sclerotium bataticola* Taub.). Frequent.
ROT (*Trichoderma Koenigii* Ould.). Common.
ROT (*Melanospora globosa* Berl.). Common. May have been secondary.
ROT (*Penicillium sp.*). Common. May have been secondary.
SCURF OR SOIL STAIN (*Monilochaetes infuscans* E. & H.). More abundant than in past years.

Sycamore.

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). Much more severe than usual.

Timothy.

RUST (*Puccinia phlei-pratensis* E. & H.). One record.

Tomatoes.

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). A few reports.
FRUIT ROT (*Macrosporium solani* E. & M.). More abundant, and more severe than usual.
FRUIT ROT (*Botrytis sp.*). Common in greenhouses and causing a blossom end rot.
STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.
BLOSSOM END ROT (Cause questionable). Common.
LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and severe.
LEAF SPOT (*Ascochyta lycopersici* Brum). Common in the greenhouse.
MOSAIC—Filiform Leaf (Cause undetermined). Very abundant in many localities.

Walnut.

LEAF SPOT (*Marsonia juglandis* [Lib.] Sacc.). Abundant.

Water Melon.

ANTHRACNOSE (*Colletotrichum lagenarium* [Pass.] E. & H.). Abundant in southern part of the State.

Wheat.

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Occasional. (*Puccinia rubigo-vera* [DeC.] Wint.). Common. (*Puccinia triticina* Erik.). Common.
SMUT (*Tilletia foetens* [B. & C.] Trel.). Frequent (*Tilletia tritici* [Beij.] Wint.). Abundant.
SMUT (*Ustilago tritici* [Pers.] Jens.). Common.
MOLD (*Cladosporium herbarum* [Pers.] Lk.). Abundant in places.

Willow.

LEAF SPOT (*Gloeosporium salicis* West). Common.

Forest and Shade Trees.

We had many complaints concerning a burning or scald of the foliage which was rather difficult to explain but apparently due to physiological conditions. We also had some few complaints of gas injury.

III.

REPORT OF POTATO SCAB EXPERIMENTS, 1915*

H. CLAY LINT.

The investigation of the influence of sulfur in the control of potato scab, *Actinomyces chromogenus* (Gasparini), which was begun by the Department of Plant Pathology in 1914 has been continued during the past summer. In 1915 attention was given to a number of factors bearing on the extent and control of the disease.

It has been impossible to continue work with all the conditions relating to the effectiveness of sulfur as a soil fungicide. Of the five lines of investigation taken up formerly, the two dealing with (1) the influence of cover crops on the control of scab as affected by sulfur, and, (2) the time of application of sulfur, were discontinued.

Very satisfactory results were obtained pointing toward a smaller benefit from sulfur on soil which had grown a cover crop than one which had not. Likewise, spring applications of sulfur proved more satisfactory than the application of an equal quantity the preceding fall. Both have practical bearing and would merit continued investigation.

The results of the experiments in 1914 show that the benefits of sulfur may vary with the type of soil and variety of potatoes. It has been found impossible to test out all these factors so that the work for 1915 has been limited to the Irish Cobbler variety. Practically all of the early grown potatoes are of this variety. It is grown commercially in all potato growing sections of the State. It has a more pronounced tendency to scab than any other commercial variety grown within New Jersey so that under the limited conditions it was considered best to use but one variety. Unfortunately, it has been impossible to have the same seed used everywhere and therefore, climatic and soil differences are not the only variants between duplicate experiments. Undoubtedly a variation in results is occasioned by differences in soil texture but because of the impossibility of testing all soil types, we have tried to locate experiments on typical potato soils ranging from the loam to sandy loam nature.

The results of many previous investigations as well as those obtained in our own work last year plainly indicate that sulfur applied to the soil can decrease the amount of scab. Several instances in which sulfur applied to potatoes has resulted in an injured stand of the succeeding grass crop has been noted. The problem of making this material desirable for general application resolved itself into that of eliminating the objectionable features.

With this object in view, the experiments of this year were designed to compare the effects of small applications for two or more years, with

*Syn. Oospora scabies (Thaxt.) Actinomyces scabies (Thaxt.) Güssow.

a heavy application for one year. The use of a sulfur-limestone mixture was tested for its relative efficiency in scab control as well as for any deleterious effect on the yield. Sherbakoff* of the Cornell Agricultural Experiment Station reports that the benefits of sulfur are not impaired and the injurious effects lessened in such a mixture.

In addition to the preceding experiments, the following lines of investigation were continued this year:

(1) The influence of the method of application. Last year a considerable variation was occasioned in the results from this cause. The method of applying the sulfur in a narrow strip on top of the row was not used this year because of the decreased production which usually results where the sulfur is so applied.

(2) The influence of the form in which the three essential elements, Nitrogen, Phosphorus and Potasium are supplied in the fertilizer.

(3) The influence of the formalin treatment of the seed on the efficiency of sulfur.

Influence of the Various Factors Tested in 1915.

FIRST: Influence of the method of application. As in this work conducted last year, this phase of the problem has been limited to those methods which are practical with a considerable acreage.

Three methods of application were tested:

(a) Mixture of sulfur with the fertilizer.
(b) Broadcasting of sulfur before planting.
(c) Broadcasting of sulfur after planting.

The time element of "before" and "after" planting is of no consequence; the principal difference being that when the sulfur is broadcasted before planting it becomes well integrated with the surface soil through the process of harrowing and planting.

Experiments covering this part of the problem were conducted in cooperation with Mr. M. F. Riley at Elmer, New Jersey, and Mr. Earle Dilatush at Robbinsville. While the degree of benefit from sulfur differs in these two experiments, yet the relative efficiency is in the same order. The method of broadcasting the sulfur being much more efficient than that of mixing with the fertilizer. This point was demonstrated last year in the experiment conducted in cooperation with Mr. Clifford Flitcraft of Elmer, New Jersey, and is substantiated by the results at two places this year. The results of the experiment in cooperation with Mr. M. F. Riley this year show an average increase in the percent of clean potatoes due to application of six hundred pounds of sulfur per acre:

(1) Mixed with the Fertilizer $= 2.28 \pm 1.117$
(2) Broadcasted after planting $= 8.39 \pm 1.59$
(3) Broadcasted before planting $= 31.39 \pm 1.57$

At Robbinsville the fact of the inefficiency of sulfur when used in mixture with the fertilizer was even more apparent. The scab was not controlled by this mixture, and the potatoes which grew in actual con-

*Sherbakoff, C. D.—Cornell Agr. Exp. Sta. Bul. 350; pp. 707-743 (1914).

tact with the mixture produced a corky epidermis which was as unsightly as the scab itself. Such a condition is shown on the potatoes in Figure 8.

That actual contact with the fertilizer produced this condition is not at all doubtful, since many tubers were clean on the upper side and suberized on the lower. The epidermal tissue was very acid to the taste, and the condition is probably explainable for that reason. The results on the scab control here show 7.01 .880 more scab on the plots receiving the sulfur-fertilizer mixture than the checks as compared with 13.6% 2.325 for broadcasting of the sulfur after planting.

The deleterious effect of the sulfur-fertilizer mixture on the yield is shown by a decrease of 27.01 bushels per acre on those plots as compared with a loss of only .15 bushels per acre for the plots receiving broadcast application after planting.

At Elmer the application of sulfur in all cases resulted in an increased yield as shown by the following results.

Increase in yield due to sulfur applied at rate of six hundred pounds per acre:

(1) Sulfur in mixture with fertilizer = 21.73 $\pm$ 6.45 bu. per acre.
(2) Sulfur broadcasted after planting 17.20 $\pm$ 4.965 bu. per acre.
(3) Sulfur broadcasted before planting 29.69 $\pm$ 6.48 bu. per acre.

Apparently there has been a reversal in the results of applying sulfur before and after planting from that obtained in 1914. The seasonal contrast from an exceptionally dry to very wet, with almost as much contrast in temperature conditions, may have caused this occurrence.

Plot Arrangement, Method of Taking and Interpreting Data With the Probable Error.

In the experimental work with sulfur this year we have used plots four rows wide by one hundred feet long in most cases. Small plots have been generally accepted as more accurate because of the fewer variations within the plot itself and particularly is this advisable in work with potato scab which is notorious for its lack of uniformity of distribution. In all experiments there have been parallel check plots either alternating with or adjacent to the treated plots.

In calculating the results the theoretical yield or per cent clean was calculated for each plot from the data for the adjacent checks. The benefit claimed for the treatment is the difference between the calculated data and the actual data. The average of the benefits so derived is then calculated rather than taking the difference of the average of all checks over that for all treated plots.

The experimental error appended to most of the figures quoted is to be taken as an index of the uniformity of the figures which go to make up the average. It also serves to tell to what extent a certain benefit is due. The experimental error is calculated by the formula $Pe. = .6745 \sqrt{\frac{\Sigma d^2}{N(N-1)}}$

In harvesting, the entire crop of each plot was picked up and the yield determined. A portion of the yield varying from one-half to the entire production was sorted into relative clean and scabbed potatoes. The weights of each class were then used for calculating the per cent of clean potatoes. In most cases the scab attack has not been so prominent as common and the grading was very strict.

SECOND: The influence of the form in which the three essential elements, Nitrogen, Phosphorus, and Potasium are supplied to the fertilizer.

An experiment testing the results obtained from the use of sulfur when used in connection with fertilizers containing nitrate of soda versus ammonium sulfate as a source of nitrogen; acid phosphate versus steamed bone as a source of phosphorus; and sulfate of potash versus chloride of potash as a source of potash, was conducted in cooperation with Mr. Jos. H. Fogg at Bridgeton, New Jersey.

Essentially the same experiment was conducted on the same area in 1914. Due to the high cost of potash salts only a 4-8-7½ fertilizer was used this year whereas 4-8-10 was used in 1914. Each fertilizer was used on the same area as the year previous. The sulfur plots of 1914 which were either seven or nine rows wide were split into two plots in 1915, one receiving sulfur again this year, the other receiving none in order to note the second influence.

The results of the experiment this year bear out those of 1914 in two out of three cases. The sulfur is more effective in combination with KCl than with K_2SO_4 and with acid phosphate than with steamed bone as shown by the following table:

Table I.

Comparison of the Influence of Sulfur in Combination With KCl Versus K_2SO_4.

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
KCl	Check	Check	37.92
K_2SO_4	Check	Check	59.00
KCl	300 lbs. S. per acre.	Check	62.20
K_2SO_4	300 " " " "	Check	65.55
KCl	300 " " " "	300 lbs. S. per acre.	66.28
K_2SO_4	300 " " " "	300 " " " "	74.50
KCl	600 " " " "	Check	61.50
K_2SO_4	600 " " " "	Check	67.20
KCl	600 " " " "	300 lbs. S. per acre.	64.60
K_2SO_4	600 " " " "	300 " " " "	60.00

Table II.

Comparison of the Influence of Sulfur Combination With Acid Phosphate Versus Steamed Bone.

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
Steamed Bone	Check	Check	43.40
Acid Phosphate	Check	Check	37.92
Steamed Bone	300 lbs. S. per acre.	Check	48.08
Acid Phosphate	300 " " " "	Check	62.20
Steamed Bone	300 " " " "	300 lbs. S. per acre.	61.65

Acid Phosphate	300 lbs. S. per acre.	300 lbs. S. per acre.	66.28
Steamed Bone	600 " " " "	Check	69.00
Acid Phosphate	600 " " " "	Check	61.50
Steamed Bone	600 " " " "	300 lbs. S. per acre.	58.20
Acid Phosphate	600 " " " "	300 " " " "	64.60

Table III.

Comparison of the Influence of Sulfur in Combination With $NaNO_3$ Versus $(NH_4)_2SO_4$

Fertilizer	*Treatment 1914*	*Treatment 1915*	*% Clean*
$NaNO_3$	Check	Check	38.65
$(NH_4)_2SO_4$	Check	Check	30.70
$NaNO_3$	300 lbs. S. per acre.	Check	41.70
$(NH_4)_2SO_4$	300 " " " "	Check	41.65
$NaNO_3$	300 " " " "	300 lbs. S. per acre.	59.20
$(NH_4)_2SO_4$	300 " " " "	300 " " " "	49.45
$NaNO_3$	600 " " " "	Check	63.85
$(NH_4)_2SO_4$	600 " " " "	Check	50.33
$NaNO_3$	600 " " " "	300 lbs. S. per acre.	55.70
$(NH_4)_2SO_4$	600 " " " "	300 " " " "	65.30

The results with nitrate of soda as compared to sulfate of ammonia are somewhat reversed, the sulfate of ammonia showing a smaller increase in three out of four possibilities than nitrate of soda. In 1914 the sulfate of ammonia gave a more pronounced difference than nitrate of soda.

Since nitrogen fertilizers are the only ones in which micro-organisms play any important role in rendering the nitrogen available, it is possible that the wide climatic differences in the two seasons may have caused entirely different biological activities. A cold and moist soil would not be as active biologically as a warmer one, but since we do not know the influence of this agent any considerations are purely theoretical.

THIRD: The influence of seed treatment by soaking in solution of formaldehyde or of corrosive sublimate, as recommended by this Department, gave promising results in 1914. This phase of the work has been continued during the present season. Two experiments covering this point in connection with sulfur application were made this year, one at Burlington in cooperation with Mr. W. J. McFarland, the other at Bridgeton in cooperation with Mr. Walter Minch. In general, the results of seed treatment bear out those of last year to the effect that (1) seed treatment will decrease the amount of scab to a certain extent even on soils contaminated with the scab organism. (2) Sulfur is more effective in controlling scab when used with treated than with non-treated seed.

The results of seed treatment at Burlington were very marked. Applications of sulfur at the rate of six hundred pounds per acre increased the amount of clean tubers about 20 per cent for both treated and untreated seed. We find that it is more difficult to increase the per cent of clean potatoes, the 20 per cent from 50 to 70 per cent than from 30 to 50 per cent, and since the treated seed was normally cleaner than the untreated, it followed that the sulfur must have been more effective to cause the same increase in the per cent of clean tubers.

FOURTH: Influence of limestone-sulfur mixtures on the control of scab.

Since these experiments were designed to cover at least two years work, any statements concerning the results before the end of the second season would be premature. The sulfur has decreased the scab, much as it has on other experiments, but subsequent applications of limestone alone, sulfur-limestone mixtures and of sulfur alone are called for in the future plans of the work and thus far these experiments show no results not heretofore brought out in other experiments. Two experiments of this type were conducted in cooperation with Mr. Hartly W. Ridgeway at Bridgeton and Mr. Carroll Burtis at Allentown, respectively.

Second Year Influence of Sulfur.

(1) On Succeeding Crops.

Two cases of injury to the hay crop following potatoes to which sulfur had been applied were noted in 1914. No permanent injury was effected in either case. The plots to which sulfur was applied last year were seeded to a variety of crops, none of which have shown any injurious effects. Corn crops planted on the experimental areas on the farms of John Prinsen, Salem; Aaron Cuff, Salem, Walter Minch, Bridgeton; John Ballinger, Mullica Hill; Edward Ackerson, Lafayette; showed no effects whatever. At Elmer in the farm of Clifford Flitcraft, the soil received about two tons of lime to the acre after potatoes and was seeded to alfalfa. In the late fall and the following spring, the sulfured areas were faintly marked by a less even stand. By the end of the following summer no differences were detectable. Alfalfa is probably as sensitive towar acidity as any of the common crops and if a satisfactory stand can be secured immediately after potatoes through the liberal application of lime, there should exist no fears of any permanent injury to the soil because of sulfur application.

(2) Influence on Succeeding Potato Crop.

The areas on which the experiments were conducted on the farms of Mr. John DuBois and Mr. D. Howard Jones at Freehold in 1914 were planted in potatoes again this year but did not receive additional applications of sulfur. It was observed that the vines on the sulfured areas died about seven days earlier than the non-sulfured areas. On Mr. Jones' farm the rows ran at right angles to the sulfured areas and it was impossible to obtain data as to any injury. On the adjacent farm of Mr. DuBois, however, the yields of tubers from the sulfured and unsulfured areas showed a slightly larger yield on the sulfured areas. These same plots in 1914 showed a pronounced decrease in yield and that no injury was done here despite the earlier death of the vines indicates no injurious after effects. As pointed out last year there exists a varietal difference in the response to sulfur applications. With the Giants there results an earlier maturity, a feature which has not been observed with Irish Cobbler vines. The amount of scab was too small to merit sorting

the potatoes grown this year on Mr. DuBois' farm, but there existed a perceptible difference in the quality of the yields from sulfured and non-sulfured areas. The potatoes on the former possessed a whiter epidermis with an apparently finer texture.

Data showing the second year influence of sulfur on the control of scab is shown by the following table of results of the experiment in cooperation with Mr. Jos. H. Fogg at Bridgeton, New Jersey.

Table IV.

The average per cent of clean potatoes for each condition is the average of six similar plots relative to sulfur treatment.

Treatment 1914.	Treatment 1915.	Average % Clean.	± Error	Increase in % Clean
Check.....	Check	41.278	3.513	.....
300 lbs. S. per A.....	Check	53.33	2.965	+ 12.955
300 lbs. S. per A.....	300 lbs. S. per A.	61.32	2.35	+ 20.042
600 lbs. S. per A.....	Check	58.46	3.225	+ 17.182
600 lbs. S. per A.....	300 lbs. S. per A.	60.89	1.012	+ 19.612

These results show a pronounced second year influence from application of both 300 and 600 pounds of sulfur per acre in 1914. While no great difference exists between any of the last three conditions noted above, still it appears as though the second year influence of 600 pounds of sulfur to the acre is greater than for 300 pounds. Two successive applications of 300 pounds of sulfur per acre appear to be more effective than only one of 600 pound per acre and also as good as 600 pounds per acre followed by 300 pounds. These results are quite indicative and have intimate bearing on the practical side of the problem of scab control by means of sulfur. Whether or not these indications are authentic will be determined by the sulfur-limestone experiments mentioned previously.

IV.

REPORT OF POTATO SPRAYING EXPERIMENTS FOR 1915.

H. Clay Lint.

Dusting and spraying experiments on Irish potatoes were first started by the Experiment Station two years ago. Since both fungus and insect enemies play an important rôle as causes of injury to the potato vines, the experiments have been conducted cooperatively by the Departments of Entomology and Plant Pathology. The work was started in 1913 under the supervision of Mr. George W. Martin of this Department. In 1914 the scope of the work was broadened by the addition of three experiments at Elmer, Robbinsville, and Freehold, respectively. These experiments were run under the supervision of Mr. A. E. Cameron of the Entomology Department.

Experiments similar in scope and nature to those of 1914 were planned and it was the privilege of the writer to supervise the work of applying the prescribed treatments. Thee work of taking the data on the yields was done by Mr. Frank Jones, one of the cooperating growers, Mr. W. H.

Komp of the Department of Entomology and by Messers W. S. Krout and W. H. Martin of the Department of Plant Pathology. Because of his having given attention to these experiments throughout the growing season, the writer has been permitted to submit this report.

Experiments this year were conducted under the conditions of the three distinct sections in which potato growing is carried on extensively. At Elmer the work was carried on in cooperation with Mr. J. Harry Kandle, on whose farm similar work has been done in both 1913 and 1914. A second experiment was located at Mt. Holly and carried on in cooperation with Mr. John Black. The third of this type was conducted in cooperation with Mr. Frank P. Jones on his farm at Freehold, N. J.

The Experiment Station has also cooperated with a number of commercial firms in this work as follows:

(1) The Union Sulfur Co., of New York City, has donated, through Mr. F. H. Pough, Manager of the Research Department, the sulfur-dust mixtures used and furnished also the machines used in applying these materials.

(2) Mr. C. D. Vreeland, manufacturing chemist of the Kil-Tone Co., of Newark, N. J., has furnished the "Improved Kil-Tone" used at Elmer.

(3) Mr. F. E. Embree, Manager of the Burlington County Farmers Exchange, has donated Hermann's Tonicide for use in the work at Mt. Holly.

(4) The Corona Chemical Company, of Milwaukee, Wis., has furnished the lead arsenate used in the dust mixture, and also a sufficient quantity for spraying the check plots and for use in combination with Bordeaux mixture.

There are three possible ways in which spraying treatments might promote a healthy development of the plants and consequently a maximum yield of potatoes.

(1) The control of insect enemies. Two insects annually cause great damage to the vines of potatoes if no control measures are practiced. The Colorado Potato Beetle (*Leptinotarsa decemlineata* Say.) is very prevalent but can be effectively controlled by the use of arsenical poisons. The Flea-beetle (*Epitrix cucumeris* Harris) is very abundant, and to date has been most successfully eliminated as a cause of injury by thorough spraying with Bordeaux mixture which acts principally as a repellent.

(2) The fungus enemies of the foliage which can be controlled by means of spraying are:

(a) The Late Blight (*Phytophora infestans* DeBarry). This fungus is very common in the potato sections of New York and New England. It sometimes attacks potatoes in the more northern counties of New Jersey, but very seldom in the large potato growing sections. With its infrequency of occurrence it is not probable that spraying would prove a profitable insurance against injury by this fungus.

(b) The Early Blight (*Alternaria solani* E. & M. Jones & Grout). This fungus seldom causes any extensive injury to potatoes in this State. A great majority of the crop is harvested before suitable conditions for the development of this fungus present themselves. On the second crop

potatoes the Early Blight is much more common. This fungus can be controlled by thorough spraying with Bordeaux mixture. An experiment this year on the second crop potatoes shows to what extent the control of this fungus is a factor in increasing the yield.

(3) Vine simulation:—The property of invigorating potato vines has been attributed by some writers to copper and sulfur compounds. To what extent transpiration is modified because of the presence of a coating of spray material has not been consistently demonstrated. Neither of these factors has been extensively tested, and to what degree they are operative, and under what conditions, is problematical.

In a ten-year experiment in New York State, it was found profitable to spray. Some years the increase little more than paid for the spray but in the long run the continued practice was found advisable. It is probable that conditions in New Jersey are less favorable to obtaining increased production than in New York, and it is probable that a satisfactory solution of the problem here can only be accomplished by continuing the work over a series of at least ten years.

Negative results were obtained in one experiment in 1915. Two positives and one negative were obtained under the different climatic conditions of 1914. Obviously, the question merited repetition this year.

Experiments at Elmer.

The experiment here was conducted on a trapezoidal-shaped field of about twelve acres. The soil is a sassafras loam to sandy loam, very uniform in texture throughout the field and well adapted to potatoes. In topography the field is slightly undulating and in ordinary years these differences would not be objectionable. With an abundance of moisture this summer these topographical differences were accentuated, tuber rotting and root suffocation resulting in some of the lower areas due to an excess of moisture.

The field was divided into twelve plots, each twenty-four rows wide. The spraying treatments of Bordeaux, sulfur-lead, sulfur zinc, Kiltone and lead arsenate alone were arranged in six plots of series I and repeated in series II. Four Bordeaux plots out of twelve were used as checks on the uniformity of the field. The two lead arsenate plots were adjacent to a Bordeaux plot.

The Bordeaux mixture used was of the 5-5-50 composition as ordinarily recommended, lead arsenate being added at the rate of 3 pounds of the powdered form to 50 gallons of Bordeaux. All liquid sprays were applied at the rate of 100 gallons per acre with a Watson Traction sprayer furnished by the Field Force Pump Company of Elmira, New York. A pressure of 60 to 80 pounds per square inch was required to deliver the correct quantity of spray to the acre. The sprayer covers four rows at a time with three nozzles to a row, one above and one at each side.

The Kil-tone (a commercial Bordeaux-lead paste) was used at the rate

of 10 pounds to 50 gallons of water. This compound was of an excellent physical nature and worked up easily into a thin paste for pouring through the strainer into the sprayer tank.

For the lead arsenate plots, 3 pounds of dry arsenate powder manufactured by the Corona Chemical Company of Milwaukee, Wis., was used to 50 gallons of water, the same rate at which it was used in the Bordeaux-lead arsenate mixture.

Two dust mixtures were used, the one containing 16-2/3 per cent of Corona lead arsenate to 83-1/2 per cent of finely ground sulfur. The second contained the same proportion of sulfur and zinc arsenate. Both mixtures were prepared for experimental purposes by the Union Sulfur Company. Of these two, the sulfur-lead mixture is applied much the easier. The latter tends to become lumpy on standing and is more compact, thus clogging the machine sometimes. The sulfur-lead mixture retained its original fineness and gave no trouble.

Four applications of spray were made, starting on May 17th, at which time the plants varied from eight inches in height or less in order as they had been planted. The second spraying was made June first, the third June 24th and the fourth July 2nd. Frequent rains delayed the application of the third spray and undoubtedly lessened any stimulating effects of the sulfur dust mixtures, since these were invariably washed off within a few days. No diseases were observed in any material quantity. A few scattered infections of early blight were noted about the time the vines started to die. (Plate V.)

On July 18th about the time the vines had fully matured the stems and leaves of the vines on the Bordeaux and Kil-Tone plots were undoubtedly greener and more vigorous than those on the sulfur dust or lead arsenate plots. The possibility of a considerable difference in the yield due to spraying treatments looked very promising. All vines were completely dead when the potatoes were dug, in the latter part of August. The results of the different spraying treatments are based on the difference between the actual yield obtained to the calculated yield for the plot based on the data of the checks.

With Bordeaux as the checks, the average yield was 389.12 (+ or —13.65 bushels) per acre. Data for the other spraying treatments show a decreased yield of 8.60 bushels for sulfur-lead arsenate; a decreased yield of 1.95 bushels per acre for sulfur-zinc arsenate, an increased yield over Bordeaux of 5.85 bushels per acre on the Kil-tone plots; an increased yield of 4.62 bushels per acre on the lead arsenate plots. The experimental error of each plot is almost as much as its deviation from the theoretical yield and all the differences are easily included in the error of 13.65 bushels of the Bordeaux average. Hence, it is obviously impossible to claim any superiority for any of the treatments used. Even assuming that these differences were authentic, in no case do they represent much over 2 per cent of the total crop which is not sufficient margin upon which to base experimental evidence.

The Experiments at Mt. Holly In 1915.

Spraying work representative of the conditions for the middle section of the State was carried on in cooperation with Mr. John Black at his farm about two miles east of Mt. Holly. The experiment was located on a large rectangular field of about 25 acres. The soil is a loam to silt loam in texture, in an excellent state of tilth and well adapted for potatoes. In topography the area is almost level, exceptionally even in this respect for so large a field. The field has been intact for over thirty years so that no differences in fertility were probable, because of past treatments. For the last seven years the crops grown have been:

1915, Potatoes; 1914, Potatoes; 1913, Timothy and Clover; 1912, Potatoes; 1911, Timothy and Clover; 1910, Wheat; 1909, Potatoes.

This year the entire area was planted with Maine seed, variety Irish Cobbler as contrasted with "second crop" New Jersey seed used at Elmer.

A very good stand was secured and the development of the vines throughout the early part of the growing season was very good. About July 1st, the yellowed appearance of the vines followed by leaf wilt, a condition very prevalent in this section, was first noted. It was observed that the vines on the two Bordeaux plots and the sulfur-zinc plot were not nearly so badly affected as the lead arsenate, Tonicide and sulfur-lead plots respectively. About one ton of 5-8-3 fertilizer per acre was used here.

The plot arrangement here was the same as at Elmer except that the series could not be repeated. The plots were 32 rows wide and over three acres in area. The liquid sprays were applied here with an "Iron Age" traction sprayer furnished for the work by the Bateman Manufacturing Company, of Grenloch, New Jersey. The dusts used and the machine for applying them were identical with the one used at Elmer. Hermann's Tonicide, a commercial Bordeaux lead arsenate paste, was tested here instead of Kil-Tone as at Elmer.

Table V.

Schedule of Spraying.

Plot No.	Treatment.	First Spray.	Second Spray.	Third Spray.	Fourth Spray
1	Sulfur-lead.....	5/26	6/9	6/22	6/30
2	Bordeaux.....	5/20	6/8	6/21	6/29
3	Sulfur-zinc.....	5.27	6/9	6/23	6/30
4	Ton'cide.....	5/19	6/8	6,21	6/29
5	Lead arsenate	5/20	6/8	6/21	6/29
6	Bordeaux.....	5/26	6/9	6/22	6/30

The row lengths here were about 1700 feet and it was planned to divide the field in half, perpendicular to the row length, and by harvesting separately, thereby duplicate the experiment. At digging time this was found impracticable so that we have but one plot of each treatment, except for Bordeaux, with two plots which served as a check on the uniformity of the field. In harvesting the plots, however, the data on the

several rows were taken in groups and from the variation in the yields of these various rows of the plot, it was possible to compute the probable error of the total yield which represents the average of the varying conditions within the plot.

The following table will show the yields of potatoes in bushels per acre:

Table VI.

Plot No.	Treatment.	First.	Seconds.	Total.	Probable error ±
1	Sul'ur-lead	238.68	34.88	273.56	5.13
2	Bordeaux	273.85	32.16	306.01	3.52
3	Sul ur-'inc	261.51	34.45	295.96	3.64
4	Tonicide	220.0	34.62	254.62	3.208
5	Lead arsenate	209.95	38.65	248.60	2.555
6	Bordeaux	242.86	27.75	270.61	4.66

The proper interpretation of the above data is rendered difficult because of the whole scheme not having been repeated and on account of having but two Bordeaux checks on the uniformity of the field. Calculating the theoretical yields, however, for the plots on the basis of these checks we obtain these results as shown in the following table.

Table VII.

Plot No.	Treatment.	Calculated Yield.	Actual Yield.	Difference
1	Sul ur-lead	314.86	273.56	−41.30
2	Bordeaux	306.01	306.01	.....
3	Sul ur-zinc	297.16	295.97	− 1.19
4	Tonicide	288.31	254.63	−33.68
5	Lead arsenate	279.46	248.60	−31.26
6	Bordeaux	270.61	270.61	.....

Apparently sulfur-zinc has given as good results as Bordeaux itself to within experimental error. That there should be any material difference in the properties of sulfur-lead and sulfur-zinc to account for the difference of minus 40 bushels between them seems improbable. This difference is more probably due to the fact that the first and third sprays on plot 1 were applied in the late afternoon of a day followed by a rain in the night, probably washing off the greater part of the material. The sulfur-zinc plots on each occasion were sprayed the following day and were not so washed off. In the light of this fact and the improbability of any real difference in the activity of the two dusts we are inclined to believe that had all conditions been the same these two plots would here have shown up equally well. If then, sulfur-zinc proved to be as good as Bordeaux to within experimental error, we can claim no superiority for the Bordeaux over sulfur-lead.

In considering the data for the Tonicide and lead arsenate plots which lie between the two Bordeaux plots, the evidence of an increased yield due to Bordeaux spraying is more apparent. That an inferior yield

should result on these plots is in correlation with the appearance of the vines. The actual difference between lead arsenate and Tonicide is within the experimental error of the plots, so that no claim of superiority of Tonicide over lead arsenate is valid. From the data, Bordeaux may have increased the yield of potatoes over Tonicide 33.68 bushels per acre and over lead arsenate by 31.26 bushels per acre. These figures must be discounted, however, by the fact that the treatments were not repeated and also by the fact that the two Bordeaux plots themselves differed by 35.40 bushels per acre, a figure larger than the difference between the actual yield for the plots in question and the calculated Bordeaux yield for those plots.

This experiment alone of the three of this type conducted this year indicates the possibility of any superiority of Bordeaux lead over a straight arsenical spray. Any superiority of Bordeaux over the sulfur dusts is doubtful, and to what extent we shall claim benefit over lead arsenate is a matter of interpretation of the data. Roughly speaking, the increase approximated 30 bushels per acre.

The Experiment at Freehold in 1915.

The potato spraying work at Freehold was conducted on an irregularly shaped field of about 17 acres on the farm of Frank P. Jones. The same area was used for the spraying experiment of 1914 at this place. The field was sub-divided into two series of six plots each the arrangement of the twelve plots being as follows:

Plot 1 Bordeaux	Plot 7 Bordeaux
Plot 2 Check	Plot 8 Check
Plot 3 Sulfur-zinc	Plot 9 Sulfur-zinc
Plot 4 Check	Plot 10 Check
Plot 5 Sulfur-lead	Plot 11 Sulfur-lead
Plot 6 Check	Plot 12 Check

The liquid spray, in this case Bordeaux-lead only, was applied at the rate of 100 gallons per acre of 5-5-50 in composition. Three pounds of Corona powdered arsenate of lead were added per 50 gallons of Bordeaux. The applications were made with an "Iron Age" traction sprayer donated for the work by the Bateman Manufacturing Company. The sulfur-zinc and sulfur-lead dusts used here were of the same composition (5-1) as used elsewhere. The applications were likewise made with the same type of dusting machine as in the other experiments.

The potatoes grown here were of the American Giant variety as contrasted with the Irish Cobblers on the other two experiments. Only three applications of Bordeaux, and the sulfur dusts could be made here since the vines so completely covered the rows as to render the mechanical injury to the vines more destructive than could be offset by the spraying.

The check plots in this experiment were sprayed with a mixture of lime and Paris green at the rate of about two pounds of Paris green to the acre. This material was applied with a Leggett duster with two nozzles per row. Mr. Jones dusted the check plots but twice, all that he considered necessary to effectively control the Colorado potato beetle. Since Paris green dusting is the most popular means of control among the potato growers of that section, the experiment resolves itself into a comparison of the Bordeaux and sulfur dusts with the common practice.

A faint difference was to be observed in the Bordeaux plots during the last stages of the death of the vines. The leaves had died on all plots and a convenient wind blew all the leaves off the stems revealing the heretofore obscured fact of the stems being greener on the Bordeaux plots. In no event was this difference nearly so well marked as at Elmer or Mt. Holly.

The results of the experiment are given in the following table.

Table VIII.

Plot No.	Treatment.	Area in acres.	Total Yield.	Bbl. per A.	Bu. per A.
1	Bordeaux	1.1413	202 bbl.	142.9	393.00
2	Paris green	1.3688	179	130.8	359.95
3	Sulfur-zinc	1.268	180	141.9	390.50
4	Paris green	1.194	186	155.75	428.50
5	Sulfur lead	1.056	180	170.5	469.00
6	Paris green	1.871	290	154.95	426.10
7	Bordeaux	1.731	270	155.95	428.84
8	Paris green	1.596	252	157.98	434.50
9	Sulfur-zinc	1.458	220	151.0	415.50
10	Paris geen	1.322	190	143.70	395.00
11	Sulfur lead	1.185	168	141.80	390.00
12	Paris green	1.0475	154	147.0	404.00

By neither method of interpreting the above figures can the writer find any legitimate difference between the yields from any of the plots due to spraying treatments. In the whole scheme Plot 5 with a yield of 469 bushels per acre between the closely agreeing checks of 428.50 and 426.10 seem to make a positive indication. Such a result is not substantiated in Plot 11, the duplicate of the above. In fact quite the reverse is true. Comparing the yields for the treated plots with the theoretical yield for such plots based on the adjacent checks shows a substantial increase for Bordeaux on Plot 1 and sulfur-lead on Plot 5. But there was a check on but one side of Plot 1, and Plot 6 parallels Plot 5 for only a little over half the length of Plot 5 as indicated by the comparative areas. Discounting these theoretical yields as partially inaccurate on these accounts and also by the fact that such phenomena fail of repetition on their corresponding duplicates, the results are in no way positive.

The mathematical averages of the plots of like treatment are all alike within experimental error as shown by the following table.

Table IX.

Plot No.	Treatment.	Bu. per A.	Average number bu. per A.	Error of average
2	Paris green.	359.95		
4	Paris green.	428.50		
6	Paris green.	426.10		
8	Paris green.	434.50		
10	Paris green.	395.00		
12	Paris green.	404.00		
Total.		2448.05	408.00	±7.83
1	Bordeaux.	393.00		
7	Bordeaux.	428.84		
Total.		821.84	410.92	±12.10
3	Sulfur-zinc	390.50		
9	Sulfur-zinc.	415.50		
Total.		806.00	403.00	±8.42
5	Sulfur-lead.	469.00		
11	Sulfur-lead.	390.00		
Total.		859.00	429.50	± 26.62

These results coincide very well with those obtained by Mr. Cameron on this area in 1914. A number of factors have been suggested as possible causes for this failure to show material difference in yields due to the spraying treatments.

(1) Soil Condition. The soil management here has been in accordance with the best practices. Exceptionally fertile naturally, the field has consistently received heavy applications of fertilizer. Each year an abundant cover crop has been turned under as well as application of manure not infrequently made. The yield of potatoes itself tells, undoubtedly, of a high state of fertility and also a uniformity thereof. The explanation that all this might suggest is that the fertility of the field is such as to permit that maximum of production beyond which further stimulation is very difficult.

(2) Spraying. The Giant vines grow very rapidly and will easily make so dense a growth as to obscure the rows within five or six weeks after the plants appear through the soil. After this condition is reached, it is highly probable that injury to the vines would more than offset the benefit of spraying. This rapid growth of the vines gives but about five weeks within which to make four applications of spray. After the last spraying which can be done about July 1st, the plants continue to grow from four to five weeks before they start to die. Growth and rains will soon leave a great proportion of the foliage uncovered, thus making conditions on all plots very much alike at this most important stage of their development. That this condition exists may serve to partially explain why it is apparently impossible to obtain differences here.

(3) Variety. Other experiments in which Bordeaux spraying has resulted in an increased yield have been on the Irish Cobbler, and varietal differences in the vines may play an important rôle.

The Experiment at Jamesburg.

In addition to the foregoing experiments another was located at the farm of Mr. H. Cortney Brown lying about one mile west of Jamesburg. This experiment was designed to test out the stimulating influence of copper compounds as they exist in Bordeaux mixture.

A small area of about five acres was divided into eight plots of sixteen rows in width. Plots 1-3-5-7 were sprayed with lead arsenate alone and the alternate plots 2-4-6-8 were sprayed with Bordeaux-lead. The spray machine here could not be adjusted to deliver more than 75 gallons of liquid per acre and in order to have the same amount of materials per acre on all the spraying experiments it was necessary to use 6 pounds of dry lead arsenate powder per 75 gallons instead of 100 gallons as used elsewhere. Likewise, the 10 pounds of lime and copper sulfate were applied in 75 gallons of water instead of 100. From one viewpoint it was unfair to compare this experiment with others since the Bordeaux was obviously more concentrated. On the other hand, the same amount of copper per acre was applied in all cases.

This area is fairly uniform in the texture of soil and in topography. It varies from a loam to silt loam in texture but well adapted to potatoes upon proper cultivation. The experiment would preferably have been run on Irish Cobblers, rather than the State of Maine variety as was actually done. Probably due to too liberal rainfall the vines here flattened out early, covering the middles between the rows so that it was impractical to spray more than three times.

No differences were noted on the vines on the various plots during the growing season and no consistent perceptible differences in the order of dying. That no real difference exists in the yields of the various plots is shown in the following table.

Table X.

Plot No.	Treatment.	Actual yield in bu. per A.	Calculated yield for Bordeaux.	Difference
1	Lead arsenate.	262.50		
2	Bordeaux-lead.	259.25	273.45	−14.20
3	Lead arsenate.	284.40		
4	Bordeaux-lead.	257.36	264.89	− 7.53
5	Lead arsenate.	255.38		
6	Bordeaux-lead.	265.80	258.39	+ 7.41
7	Lead arsenate.	261.41		
8	Bordeaux-lead.	250.21		

Obviously these results show a minus difference which would be easily within experimental error so that no indicative results can be attributed to this experiment.

The Experiment on "Second Crop" Potatoes at Elmer, 1915.

A very common practice in South Jersey is to grow a second crop of potatoes on the same area utilized for growing early potatoes. Ordinarily, the first crop will have been dug and the soil prepared so that the second

crop can be planted from the 25th of July up until as late as September first. This year, however, the first crop in many cases was dug too late, because of low prices, to permit this practice. In general, however, any late-planted early variety of potatoes is called "Second Cropper" whether the first crop field or another is used. Some growers will secure northern stock for growing the second crop potatoes and then use this second crop for early seed the following spring. Others, as was the case with the grower with whom we cooperated, put a part of their own second crop seed in cold storage until the following summer to be used for late seed again. Which of these two methods produces the more vigorous seed, or is more free from disease, has not been sufficiently studied.

In order to test the value of the different spraying and dusting mixtures on second crop potatoes, the following experiment was conducted in cooperation with Mr. J. Harry Kandle at Elmer, N. J. The same field which was used for growing the first crop could not be used. A field of twelve acres of a similar type of soil, but much better adapted for experimental purposes, from the standpoint of topography, was used.

The area was divided into fourteen plots of approximately the same size. These plots were twenty rows wide and arranged in the following order:

Plot 1 Bordeaux mixture.	Plot 8 Sulfur-lead arsenate
Plot 2 Sulfur-lead arsenate.	Plot 9 Lead arsenate.
Plot 3 Lead arsenate.	Plot 10 Bordeaux mixture.
Plot 4 Bordeaux mixture.	Plot 11 Sulfur-zinc arsenate.
Plot 5 Sulfur-zinc arsenate.	Plot 12 Lead arsenate.
Plot 6 Lead arsenate.	Plot 13 Bordeaux mixture.
Plot 7 Bordeaux mixture.	Plot 14 Sulfur-lead arsenate.

The rates of application and the mixtures used were identical with those used on the first crop experiment conducted on this farm. The entire field with the exception of nine rows was planted with second crop Irish Cobbler stock, grown by Mr. Kandle in 1914, and kept in cold storage until July of 1915. Weather conditions and other work interfered so that the field was planted on three different dates, about July 27th, August 4th, and August 10th, respectively. These dates are only approximately correct, since no accurate record was taken. The fact of these differences in planting dates is probably of less consequence than it would have been for early potatoes. The vines all grew to a normal maturity before frost and, as a whole, the growing period for each planting was very similar to that of any other of the plantings. Reference to the data shows a striking uniformity in the duplicate series regardless of this factor, thus bearing out the probability of its minor importance.

At the time of the first spraying on August 23rd, the heights of the vines were 10 to 12 inches, 8 to 10 inches, and 3 to 6 inches respectively, for the different plantings. By the time of the second spraying on

September 8th, these differences in height were not noted, although the vines of the first planting were probably slightly wider in the rows.

On September 24th, when the third and last applications were made, no differences in the development were observed. The vines died in the same order as planted and on October 16th those of the first planting were dead, the second almost so, and the third planting had started to die.

During the first ten days of August, great numbers of adult Colorado potato beetles from an adjacent first crop field invaded Plot 1 and a part of Plot 2, clipping many of the young plants off even with the soil. The plants were heavily dusted with lead arsenate and the beetles killed. The plants soon recovered and apparently were as far advanced as the other vines at the time of the second spraying. Reference to the table of yields will show, however, that these plots gave a yield very much lower than the rest of the field. These plots were disregarded in calculating the results of the experiment.

The potatoes were dug during the first week of November and the yields of the different plots are shown in the following table:

Table XI.
Showing Yields of Plots in "Second Crop" Spraying Experiment at Elmer.

Plot No	Treatment	Bas. per A.	Bu. per A.
1	Bordeaux	185.42	115.89
2	Sulfur-lead	318.62	199.13
3	Lead arsenate	394.99	246.86
4	Bordeaux	473.45	295.92
5	Sulfur-zinc	367.31	229.57
6	Lead arsenate	338.28	215.85
7	Bordeaux	463.58	889.73
8	Sulfur-lead	366.78	229.71
9	Lead arsenate	381.10	238.19
10	Bordeaux	417.47	260.37
11	Sulfur-zinc	365.92	228.70
12	Lead arsenate	393.73	246.10
13	Bordeaux	450.16	281.35
14	Sulfur-lead	361.65	226.02

The above arrangement of the plots permits of two methods of calculating the results. Using the lead arsenate plots as checks and calculating the corrected yield for the intervening treated plots, we find an average increase in the yield of 44.5 ± 7.475 bushels per acre due to Bordeaux spraying. Sulfur-lead arsenate and sulfur-zinc arsenate show an average decrease of 13.68 and 5.68 bushels per acre, respectively.

Making the calculated yields for the plots on the basis of the Bordeaux plots as checks, we find an increased yield of 47.02 bushels per acre over lead-arsenate, 57.29 bushels per acre over sulfur-lead and 51.47 bushels per acre over sulfur-zinc.

By still another method of analyzing these data, that of the mathemati-

cal averages we find the average yield on the plots of the various treatments to be:

Lead arsenate = 236.75 bu. per A.
Bordeaux mixture = 281.84 bu. per A.
Sulfur-zinc = 229.13 bu. per A.
Sulfur-lead = 227.36 bu. per A.

By this method is shown an increase of 45.09 bushels per acre due to Bordeaux spraying with 7.62 and 9.39 bushels per acre decrease for sulfur-zinc and sulfur-lead respectively.

Obviously, these three methods of analyzing the data show the same result of an average increase of about 45 bushels per acre for Bordeaux over lead arsenate. From the economic standpoint we may calculate the net profit. These potatoes sold in the field for $1.12 per bushel, which would give a gross increase of $50.40 per acre. The cost of making three applications of Bordeaux here amounts to $8.25 per acre which would leave a net profit of $42.15 per acre. About one dollar per acre might then be legitimately deducted for the cost of picking up the increased yield. No other extra work was involved since farmers bought these potatoes in the field and hauled them away themselves.

A number of factors were operative under the conditions for the second crop experiment which were not for the first crop, and these may serve to explain why such pronounced results were obtained in this case, and not in the former.

(1) Weather conditions. With our incomplete knowledge of the influence of climatic conditions on the effectiveness of spraying mixtures, we do not know to what extent they are operative. Obviously, there are great differences between a spraying season of May from 17th to July 2nd and August from 23rd to September 24th.

(2) Vine stimulation. This may have intimate correlation with climatic conditions and may have been more pronounced. Prolonged growth on the Bordeaux plots was, however, no more marked on the second crop than on the first crop where no influence was noted.

(3) Fungus enemies. The second crop potatoes were badly infected with Early Blight. Even before the first spraying was done there were many infected leaves throughout the field. The Bordeaux mixture very effectively controlled this disease and no doubt the major part of the increased production is attributable to this cause. The sulfur dusts appeared to control this disease to a certain extent but not effectively.

No insect enemies were operative upon the vines of this second crop and since lead arsenate is admittedly not especially fungicidal, the action of Bordeaux alone as a stimulant and fungicide seems well defined.

To what extend the Early Blight has been a factor can only be determined by a repetition of this experiment over a series of years during some of which it may not be a factor.

Summary of Spraying Work in 1915.

(1) In one of the spraying experiments on early crop potatoes there was an increase in the yield due to Bordeaux spraying.

(2) From a consideration of the results of three years' experiments, it appears that the climatic conditions may play an important rôle in deciding to what extent the benefits from Bordeaux spraying will be realized. Whether or not such practice proves profitable commercially, will probably be decided only through a repetition of these experiments for a series of years.

(3) Sulfur dust mixtures have given good indications but their effectiveness as compared with Bordeaux has not been clearly established through these experiments.

(4) The state of cultivation and the fertility of the field apparently have intimate relation to the benefit to be derived from spraying.

(5) It appears probable that different varieties of potatoes respond differently to spraying treatments.

(6) Bordeaux mixture has given the best control of the flea beetles of any of the mixtures applied this year.

(7) Bordeaux, both home-made and commercial preparations, prolongs the life of the vines, but the expected increase in yield from such treatment has not resulted consistently.

(8) Bordeaux spraying in an experiment on second crop potatoes gave an average increase of about 45 bushels per acre. The net profit realized was $41.15 per acre.

(9) Early Blight was very prevalent in the plots of the second crop experiment and it is probable that the control of this fungus may account for much of the increase in yield due to Bordeaux spraying.

PLATE I.

FIG. 1.—Apple blotch.

FIG. 2.—Black Rot of the grape.

Plate II.

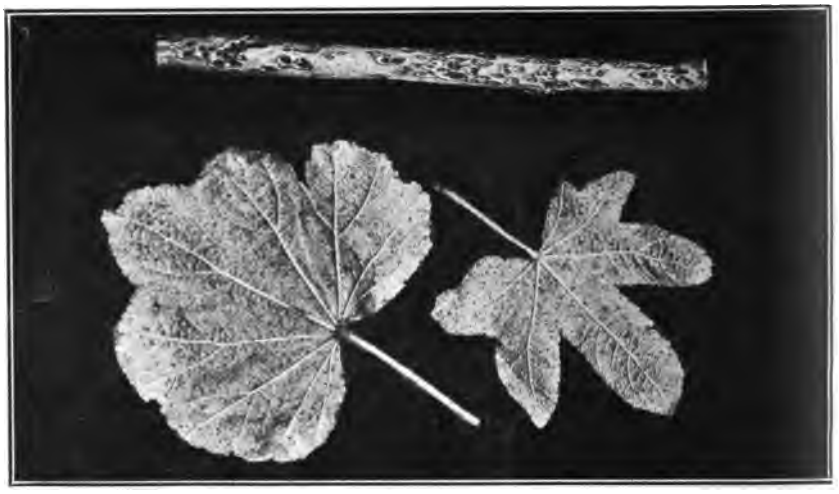

Fig. 3.—Hollyhock Rust.

Fig. 4.—Brown Rot of the peach causing a die-back of the twigs.

PLATE III.

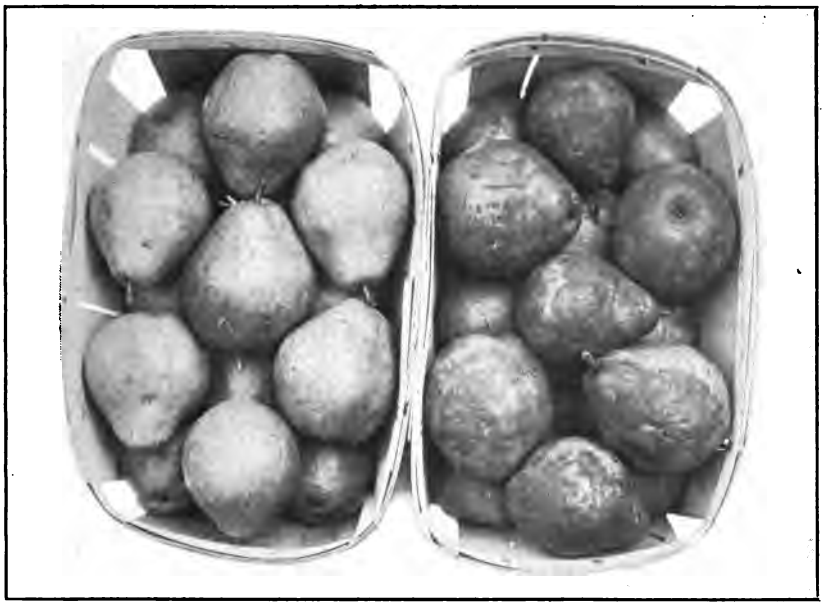

FIG. 5.—Brown Blotch on the Kieffer pear; sprayed and unsprayed fruit.

FIG. 6.—Brown Blotch of the Le Conte pear.

PLATE IV.

FIG. 7.—Effects of Brown Blotch after keeping pears in laboratory one week. The diseased fruit is very much shrunken.

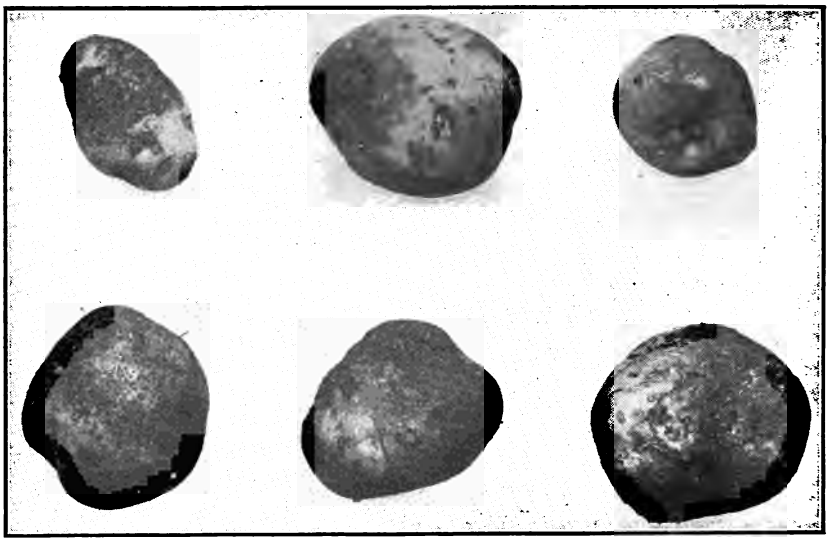

FIG. 8.—Potatoes grown in actual contact with sulfur develop a corky epidermis.

PLATE V.

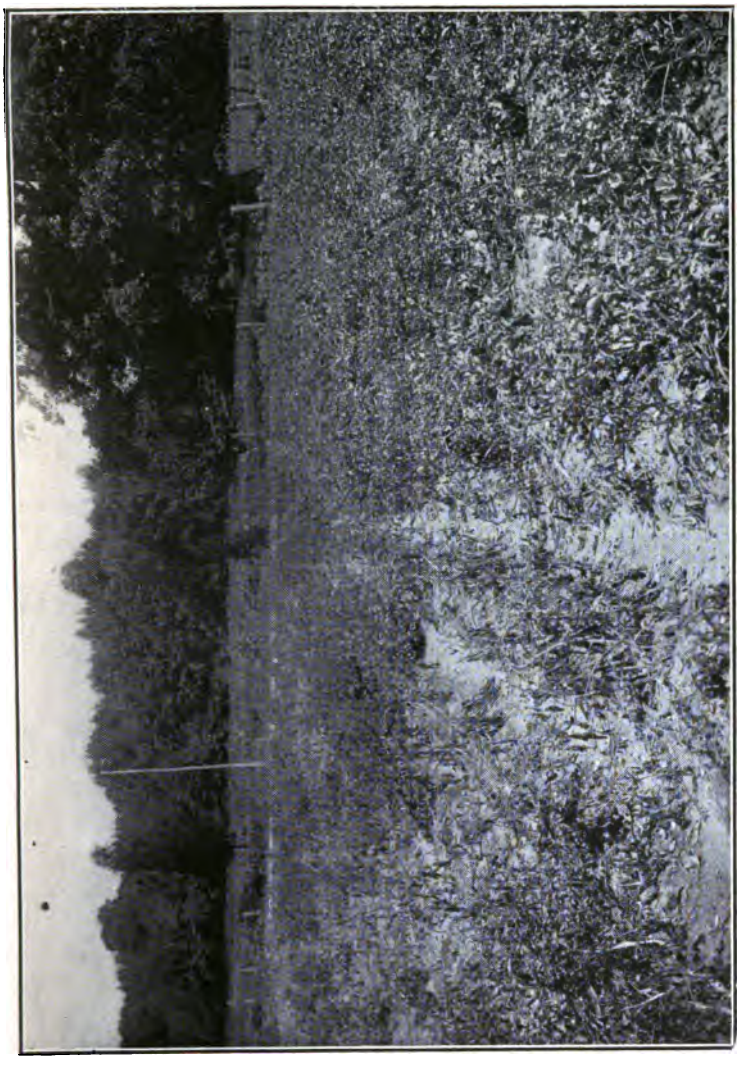

FIG. 9.—Results of spraying with lead arsenate and Bordeaux mixture; lead arsenate on the left and Bordeaux mixture on the right.

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REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
OCTOBER 31, 1916

TRENTON, N. J.
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1917

REPORT OF
DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

WILLIAM H. MARTIN, A.B., *Research Assistant.*

WEBSTER S. KROUT, M.SC., *Research Assistant.*

CONTENTS.

		PAGE
I.	Organization,	561
II.	Climatic Conditions,	561
III.	Cooperation,	562
IV.	Other Work,	562
V.	Plans for 1916–17,	563
VI.	Nursery Inspection,	564
VII.	Epidemics,	565
VIII.	Publications,	565
IX.	Needs,	566
X.	Most Common Diseases of the Year,	567
XI.	Tomato Spraying Experiments at Salem, N. J.,	575
XII.	Report on Diseases of Celery,	584
XIII.	Report of Potato Spraying Experiments,	604
XIV.	Report of the Sulfur-Potato Scab Experiments in 1916,	618

Report of the Department of Plant Pathology

MELVILLE THURSTON COOK

I

ORGANIZATION

The organization of the department is practically the same as last year. Mr. W. H. Martin, B.A., of the University of Maine, and Mr. W. S. Krout, M.S., of the Ohio State University, continue as assistants in both the Experiment Station and the College. The Union Sulphur Company Fellowship, which Dr. H. Clay Lint has held for the last three years, terminated October 1. Mr. G. W. Martin, M.S., former assistant in the department, spent one month during the summer working on the *brown blotch* of the pear. This problem is unfinished, tnd will require at least one more season's work. Mr. C. M. Haenseler, M.S., of the University of Tennessee, has been appointed to the fellowship established by the New Jersey Zinc Company for the study of "Fungi Injurious to Paints." Mr. C. A. Schwarze, M.A., of Columbia University, continues with us as Assistant State Plant Pathologist, and Mr. Edgar L. Dickerson, B.S., of Rutgers College, was employed as special Assistant State Plant Pathologist during July and August to assist in the nursery inspection work. Mr. Ralph B. Lott, of Greenwich, New Jersey, was employed as Special Inspector during November and December of 1915 and March, April and May of 1916.

II

CLIMATIC CONDITIONS

There was more rainfall during the spring and summer than usual. This resulted in a large number of fungus diseases of cultivated crops and a number of calls for personal visits to farms, which it was impossible to meet. The correspondence during the spring and summer was heavier than for the corresponding period for the past four years. During the fall the correspondence was lighter than for the corresponding period of the past four years. It is unfortunate that we are unable to meet this demand for personal visits to farms and that we are unable to conduct demonstrations in control of plant diseases.

III

COOPERATION

Experiments for the control of the common potato scab with sulfur were conducted by Dr. H. Clay Lint on the farms of Mr. Walter Minch, Bridgeton; Mr. M. F. Riley, Elmer; Mr. W. J. MacFarland, Burlington; Mr. Earl Dilatush, Robbinsville, and Mr. J. C. Burtis, Allentown. The results of this work are appended to this report (page 618).

Experiments for the control of foliage diseases of the potato by the use of dust (lead arsenate and sulfur) and Bordeaux mixture were conducted by Dr. H. Clay Lint on the farms of Mr. Edward Winsor, Farmingdale; Mr. John Black, Mt. Holly; Mr. H. Courtney Brown, Jamesburg, and Mr. J. Harry Kandle, Elmer.

Experiments for the control of the diseases of celery were conducted by Mr. W. S. Krout on the farm of Mr. Tunis Drenth, of Oradell, New Jersey. The results of this work are appended to this report (page 584).

Experiments on the control of the diseases of tomatoes were conducted by Mr. W. H. Martin on the farm of Miss Jennie Waddington, at Salem, New Jersey; the New Jersey Agricultural Experiment Station, the Truck Disease Laboratory of the United States Bureau of Plant Industry and the H. J. Heinz Company, coöperating. The results of this work are appended to this report (page 575).

IV

OTHER WORK

In addition to the coöperative work, Dr. Lint and the writer have continued their studies on the influence of diseased seed potatoes on the crop, using seed furnished by the United States Bureau of Plant Industry, the Department of Plant Pathology of the Maine Agricultural Experiment Station, the Department of Plant Pathology of the Vermont Agricultural Experiment Station and seed sent in by growers for examination.

Dr. Henry Clay Lint has made studies on Rhizoctonia.

Mr. W. H. Martin has made studies on the effect of Bordeaux mixture on transpiration, using potted plants of economic importance and abscised leaves. Mr. Martin has also coöperated with Dr. J. W. Shive, plant physiologist of this Station, in studies on transpiration. Mr. Martin and Mr. Schwarze have made studies on sclerotial fungi destructive to ornamental plants. This work is incomplete, but will probably be ready for publication in the near future.

Mr. W. S. Krout has made studies on the diseases of eggplants and comparative studies on bacterial nodules of alfalfa, nematode galls on alfalfa and other plants. Mr. F. P. Schlatter, B.S., fellow in the Department of Botany, has been making special studies on the distinctive characters and relative importance of the fungus diseases of the cranberry and related plants.

During the spring seed from cabbage, known as "Wisconsin–Hollander No. 8," was received from the Department of Plant Pathology of the Wisconsin Agricultural Experiment Station, where it had been developed and proved resistant to cabbage "yellows." This seed was distributed to several of our growers with request that it be grown and reports made to this department. For various reasons only one grower gave a report, and his farm was afterwards visited by the writer.

The seed had been planted on soil on which cabbage had proved a failure in past years, and ordinary cabbage planted on either side of the plot. The "Wisconsin–Hollander No. 8" gave an almost perfect stand, while nearly all the plants of the ordinary cabbage were dead, and the few living plants were worthless. An examination of the ordinary cabbage showed an abundance of "black rot" and "Rhizoctonia."

The writer and Mr. Schwarze have been working for the past four years on an illustrated publication on "Parasitic Fungi of New Jersey." This has been carried on as a side study, purely incidental to the regular work, and was originally started as an aid in the keeping of accurate data. The first installment of this work is now ready, and will be published in the near future.

V

PLANS FOR 1916-17

The following lines of work are proposed for the coming year:

Studies on the influence of disease on seed potatoes by Dr. Mel. T. Cook and Mr. C. M. Haenseler.
Studies on crown gall by Dr. Cook.
Studies on crown gall and legume galls by Dr. Cook and Mr. W. H. Martin.
Sclerotial diseases by Mr. Martin and C. A. Schwarze.
Studies on mosaic diseases by Mr. Martin.
Studies on club root and nematode galls by Mr. W. S. Krout.
Studies on the diseases of celery by Mr. Krout.
Studies on the influence of fungi on paints by Mr. C. M. Haenseler.
Studies on the diseases of greenhouse plants by Mr. Haenseler.
Studies on the influence of soil sterilization on seeds and seedlings by Mr. John Monteith.
Studies on varieties of beans resistant to anthracnose by Mr. E. J. Owen.
Studies on the brown blotch of the pear by Mr. G. W. Martin.

VI

NURSERY INSPECTION

The nursery inspection work under the State Department of Agriculture has been carried on in accordance with the State law. The coöperation on the part of the nurserymen is very encouraging. The shipments of nursery stock into the State have been inspected as thoroughly as circumstances permitted. Probably the most important development in this work has been the discovery of the blister rust of the white pine in the State. This disease was first discovered in the State in 1911 by the State forester, Mr. Alfred Gaskill, and the planting voluntarily destroyed by the owners. Since that time the writer has found small infections in three nurseries, and in every case the stock was destroyed. During the past spring Mr. Ralph B. Lott made an inspection of the nurseries carrying white and other 5-leaved pine stock, but failed to find the disease. Later in the season the Forest Pathology Laboratory coöperated with the State Department of Agriculture by sending Mr. Paul V. Siggers into the State to make special inspections. Mr. Siggers received special training for this work, and his inspections were exceptionally thorough. In one place he found 48 diseased trees in a planting of 1,650. This planting had been inspected by us, but not within the past two years, owing to the owner not wanting a certificate. The trees were shipped to New Jersey from New York, but probably came originally from Europe, and practically the entire shipment is intact. All the diseased trees were destroyed. On a neighboring private estate 12 trees from the same shipment were found to be diseased, and were destroyed. In one nursery one diseased tree was found in a planting of 200; these had been shipped from Germany several years ago. In another nursery 15 diseased trees were found in a planting of 1,400 trees received from France. In another nursery some 15 or 16 thousand black currants were found to be infected, and the foliage burned.

This is a European disease, which is very destructive to the white and other 5-leaved pines. It was introduced into this country in 1909, but did not gain much headway until 1915, when it spread rapidly throughout some of the New England States and New York. It has also been found in some other States. The fungus has its alternating stage on members of the genus *Ribes* (currants and gooseberries). A full discussion of this disease will be found in Farmers' Bulletin 742, of the United States Department of Agriculture.

VII

EPIDEMICS

Several plant diseases were sufficiently severe to be classed as epidemics. They were:

"Peach yellows" and "little peach," which were much more severe than for many years past. Severe outbreaks occurred in well-kept, apparently healthy, orchards.

The "mosaic" of the tomato was exceptionally severe and, undoubtedly, a great factor in reducing the yield.

The "mosaic" of pepper was very severe, but its importance is not recognized by many growers.

The "mosaic," "leaf roll" and "Rhizoctonia" of the potato were the cause of heavy losses.

The "early blight" of the celery was the cause of heavy losses in the celery-growing localities.

The "fire blight" of the apple and pear was epidemic, but not so severe as in 1915.

Shade Trees

In addition to these epidemics we have received a great many complaints concerning shade trees, the leaves wilting or falling and, in some cases, the trees dying. In some few cases we found fungi or other causes of the troubles, but in most cases failed to find any organism that would account for the condition. The question was the subject of several communications with State Forester Alfred Gaskill. It is our opinion that the condition was, in most cases, due to physiological factors, lack of water or food. Many shade trees are so placed that they suffer from lack of both water and food even though there may be a heavy rainfall.

Fume Injuries

We also had several complaints concerning injuries to vegetation, which are evidently due to fumes from brick kilns and manufacturing establishments. These injuries were always associated with rainfall, which, no doubt, carried the injurious gases downward.

VIII

PUBLICATIONS

The following publications have been issued since our last report:

Circular 50, "Common Diseases of Beans," by Mel. T. Cook.

Circular 51, "Diseases of Grains and Forage Crops," by Mel. T. Cook and J. P. Helyar.

Circular 52, "Common Diseases of the Pear," by G. W. Martin.

Circular 53, "Potato Diseases in New Jersey," by Mel. T. Cook and H. Clay Lint.

Circular 55, "Common Diseases of the Grape," by Mel. T. Cook.
Bulletin 291, "The Influence of the Tannin Content of the Host Plant on Endothia Parasitica and Related Hosts," by Mel. T. Cook and Guy West Wilson.
"Two Interesting Diseases of Greenhouse Tomatoes," by Mel. T. Cook and C. A. Schwarze, in Phytopathology, v. 6, p. 364–366, August, 1915.

IX

NEEDS

In my discussion of the needs of the department, I must repeat my statement of last year, that the demands of the farmer for personal inspection of growing crops and the heavy correspondence necessitates the employing of an associate plant pathologist. There is also a very great need for a thoroughly trained man to direct demonstration work. The necessity for a specially trained man to direct such work will be appreciated when we take into consideration the fact that many radically different diseases requiring different treatments go under the same common name among the laity, and that some diseases that cannot be controlled by spraying are likely to appear and confuse and discourage the grower. Furthermore, demonstration work in the control of plant diseases should be followed closely enough to secure accurate data. Since the results vary from year to year in accordance with climatic and other factors, an experimental element is necessarily introduced.

The potato growing industry is of very great importance, and should have the undivided attention of one man. This problem involves seed culture, spraying, etc. The most important factor in this problem is that of disease. The seed carries diseases, some of which cannot be eradicated by treatment, necessitating a long period of experimental work with both northern and home-grown seed. This involves coöperation with the United States Bureau of Plant Industry and the experiment stations of several northern States.

The "mosaic" disease of the tomato and pepper is the cause of heavy losses, and should receive a great deal of attention. Other diseases of the tomato, such as Fusarium wilt, are very threatening, and should receive special attention. The spraying of tomatoes and potatoes needs to be thoroughly tested in different parts of the States. The conditions in this State are so varied that results in one part are not necessarily an index of the results in other parts.

Other diseases that should be investigated are the wilt diseases of the eggplant, wilt and blight diseases of melons and cucumbers, root and leaf diseases of alfalfa and other legumes, diseases of shade trees and diseases of ornamentals.

The Herbarium

Unfortunately our herbarium has been neglected for several years. The mounted plants should be gone over carefully and put in place. Several hundred unmounted plants should be mounted and properly distributed so that they can be used.

X

MOST COMMON DISEASE OF THE YEAR

The following is a list of the diseases collected by members of the staff of this and other departments and sent in by the growers:

ALFALFA

LEAF SPOT (*Pseudopeziza medicaginis* (Lib.) Sacc. This disease has been about the same this year as in past years. It is no doubt the cause of much heavier losses than is appreciated by most growers.

WHITE SPOT (Cause undetermined). Prevalent but not causing a falling of the leaves. We also find a similar spotting on the clovers.

LEAF SPOTS (*Pleospora sp.* and *Cercospora medicaginis* E. & E. and *Stagnospora carpathica* Baueml.). Occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes, were sent in from time to time. There was also a very severe yellowing or blighting of certain fields throughout the State. This was apparently associated with soil conditions.

ROOT GALL (*Nematodes*). This trouble was found in a few places, but we are unable to say just how widely distributed or how injurious.

ROOT ROTS (*Thielavia basicola* (B. & Br.) Zopf. *Rhizoctonia.* These rots have been found in a few places, but we are unable to say just how widely distributed or how injurious.

Note.—The diseases of the alfalfa promises to increase in importance. The problem involves the selection of varieties, cultural methods and the study of the diseases. It will necessitate the combined work of the agronomist and the plant pathologist.

AMPELOPSIS

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

DIE BACK (*Cladosporium sp.*). This disease occurs on the *A. tricuspidata.* It was much less severe than in 1915. This was probably due to the heavy rainfall throughout the season.

APPLE

JONATHAN SPOT (*Alternaria sp.*). A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be equally severe from year to year.

Other very similar spots are no doubt due to other causes. The study of these minor apple spot rots is of greater importance than is at first apparent. They no doubt serve as points of infection for other and more serious rot organisms.

BLOSSOM END ROT (*Alternaria sp.*). This disease continues to cause a great deal of trouble with many varieties. It is frequently assocated with the black rot.

ANTHRACNOSE, or BITTLER ROT (*Glomerella ruformaculans* (Berk.) S. & Von. S.). Several records. More common than usual.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). This disease was less destructive than in 1915. However, it was very abundant in many orchards in the southern half of the State and more severe in the northern half than in 1915.

BLOTCH (*Phyllosticta solitaria* E. & E.). This disease has been very severe on some varieties, specially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* (Schw.) Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This disease was prevalent throughout the State, but did not reach the proportions of an epidemic. One extremely interesting case was where the conidial stage of the organism had wintered on the twig. The possibility of this occurring has been the subject of considerable dispute.

BROWN ROT (*Sclerotinia fructigena* (?) (Per) Schroet.). Occasional.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphaeropsis malorum* Pk.). Common and about as severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the State. (*G. globosum* Farl.). Occasional.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith & Townsend). This very common disease is receiving more attention from both nurserymen and growers. We have had several reports concerning it.

WATER CORE. Occasional.

SPRAY INJURY. Occasional.

STIPPEN (*Cylindrosporium pomi* Brooks). Two records.

WINTER INJURY. Less common than for several years.

ASPARAGUS

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

ROOT ROT (*Rhizoctonia sp.*). This organism was found to be very destructive in one planting and reports indicate that it may be prevalent in other places.

ASTER

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. We have had a less number of complaints than usual.

ROOT ROT (*Fusarium sp.*). Several records.

AZALEA

GALLS (*Exobasidium vaccinii* Fel. Wor.). Several reports. One very severe case on azaleas in a nursery.

BARLEY

SMUT (*Ustillago nuda* (Jens.) Kell. & Sw.). Very common and in some cases very abundant.

POWDERY MILDEW (*Erysiphe graminis* D. C.). Occasional.

BEANS

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). This disease was very abundant, but was less severe than in 1915. It was the cause of many complaints. (Plate I, fig. 1.)

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.

POD SPOT (*Phoma subcircinata* E. & E.). This disease was very common on the lima beans.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Common on the lima bean. Some very severe outbreaks in the southern part of the State following damp, foggy weather.

ROOT ROT (*Rhizoctonia sp.*). This organism is frequently present in cankers on the stems. It was frequently associated with *C. lindemuthianum*.

BEET

LEAF SPOT (*Cercospora beticola* Sacc.). Quite common.

ROOT ROT (*Phoma betae* Frank). This rot has been found in a few cases in both fields and storage.

Blackberry

Anthracnose (*Gloeosporium venetum* Speg.). Common and destructive in many places.
Leaf Spot (*Septoria rubi* West.). Common.
Rust *Gymnoconia peckiana* (Howe.) Tranz.) Common and the subject of many inquiries.

Cabbage, Cauliflower and Kohlrabi

Club Root (*Plasmodiophora brassicae* Wor.). This disease was reported from several localities.
Black Rot (*Pseudomonas campestris* (Pammel) Smith). Reported frequently, and in most cases very destructive.
Damping Off (*Rhizoctonia* and *Fusarium*). Several reports.

Cantaloup

See Muskmelon.

Carnation

Rust (*Uromyces caryophyllinus* (Schrank) Wint.). Common, but not serious.
Root Rot (*Rhizoctonia*). Common, but not serious.
Yellows (?). Serious on some varieties.

Catalpa

Leaf Spot (*Macrosporium catalpae* Ell. & Mart.). Common.
Leaf Spot (*Phyllosticta catalpae* Ell. & Mart.). Common.
Note.—These leaf diseases were accompanied by a falling of the leaves which many people supposed was due to the disease. The spotting was no more severe this year than in previous years, and the falling was probably due to other causes.

Cedar

Rust (*Gymnosporangium juniperi-virginiana* Schw.). (*Gymnosporangium germinale* (Schw.) Kern). Reported, but of little importance. The former was most abundant in Cape May County. *G. botryapites* was found to be quite abundant in Atlantic County.

Celery

Damping Off (*Fusarium sp.*). Common in seed-beds.
Early Blight (*Cercospora apii* Fr.). Reported from several places. Very destructive.
Late Blight (*Septoria petroselini* Desm. var. *apii* Br. & Cav.) (Bacterial). Very abundant in certain localities and most important celery disease in the State.
Crown Rot (Bacterial). Very severe in many localities.
Heart Rot (Bacterial). Very severe in many localities.

Cherry

Brown Rot (*Sclerotinia fructigena* (Pers.) Schroet). Common.
Leaf Spot (*Cylindrosporium padi* Karst.). Common and the subject of many complaints.
Winter Injury. Several complaints.

Chestnut

Bark Disease (*Endothia parasitica* (Mur.) Ander.). Common throughout the State.
Leaf Spot (*Actinopelte japonica* and *Marssonia ochroleuca* B. & C.). Frequent.

Citron

Leaf Spot (*Cercospora citrullina* Cke.). Common.

Crimson Clover

Crown Rot (*Sclerotinia libertiana* Fuckel.). Less frequent than usual.

Red Clover

Rust (*Uromyces trifolii* (Hedw.) Lev.). Occurs throughout the State.
Anthracnose (*Gloeosporium caulivorum* Kirchner). One record.
White Spot (?). Same as on alfalfa.

White Clover

Leaf Spot (*Stagnospora carpathica* Bauml.) One record.

Sweet Clover

Stem Spot (*Ascochyta caulicola* Laubert). One record.

Corn

Smut (*Ustilago zeae* (Beckm.) Ung.). This very common and very widely distributed disease is not often serious except on sweet corn.
Wilt (*Pseudomonas stewarti* Erw. Smith). Very few reports.
Rust (*Puccinia sorghii* Schw.). Not serious.
Leaf Blotch (*Helminthosporium insconspicum* C. & E.). Common. Farmers attribute this to weather.

Cowpea

Leaf Spot (*Cercospora dolichii* E. & E.). Frequent.

Cranberry

Scald (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the State, and the cause of considerable loss where the bogs were not well sprayed.
Gall (*Synchytrium vaccinii* Thomas). Found on the wild plants growing near commercial bog. Also found on the blue berries associated with the diseased cranberries.
False Blossom (Cause undetermined). Found in several bogs. It is known that this disease was brought into the State on plants from Wisconsin, but it is by no means certain that it was not already in the State.
Rot (*Acanthorhynchus vaccinii* Shear). Abundant where the vines are heavy and the spraying cannot be done effectively.
Anthracnose (*Glomerella rufomaculans vaccinii* Shear). Gloeosporium stage abundant.
Minor diseases (*Pestalozzia guepini* Shear) on old vines; (*Sporonema oxycocii* Shear) on leaves and berries; (*S. pulvinatum* Shear) on leaves; (*Microsphaeria vaccinii* Shear) on leaves where bogs had been brunt over.

Cucumber

Wilt or Blight (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed and the cause of considerable loss.
Downy Mildew (*Plasmopara cubensis* (B. & C.) Humphrey). Common and frequently the cause of heavy losses.
Leaf Spot (*Macrosporium cucumerinum* E. & E.). Frequent.

Currants

Cane Blight (*Botryosphaeria ribis* G. & D.). Several reports of this disease indicate that it is very destructive on red currants throughout the State.
Leaf Spot (*Septoria ribis* Desm.). Very common.
Rust (*Cronartium ribicola* Kleb.). Found in one place in the State. The Peridermiun stage has been found on the pines in other places. (See page 564.)

Dahlias

Leaf Spot (*Phyllosticta sp.*). Common.

Dewberry

Double Blossom (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand picking of the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

Anthracnose (*Gloeosporium venetum* Speg.). Very abundant and in some cases destructive.

Leaf Spot (*Septoria rubi* West.). Common.

Rust (*Gymnoconia peckiana* (Howe.) Tranz.). Reported as common and in some cases destructive.

Eggplant

Leaf Blight (*Phomopsis vexans* (Sacc. & Syd.) Harter). Very common and in some cases destructive.

Wilt (*Fusarium sp.*) Common and destructive.

Gladiolus

Bulb Rot. Cause undetermined. Several complaints.

Gooseberry

Anthracnose (*Pseudopeziza ribis* Kleb.). Gloeosporium stage has been found in several places.

Leaf Spot (*Sèptoria ribis* Desm.). Common.

Grape

Black Rot (*Guignardia bidwellii* (Ell.) Viala & Ravaz.). Common and very destructive in many vineyards in the southern part of the State.

Anthracnose or Bird's Eye Rot (*Gloeosporium ampelophagum* Sacc.). Occasional.

Ripe Rot (*Gloeosporium fructigenum* Berk.). Occasional.

Necrosis (*Fusicoccum viticolum* Reddick). Occasional.

Downy Mildew (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.

Bitter Rot (*Melanconium fuligineum* S. & V.). Occasional. (Plate I, fig. 2.)

Hollyhock

Rust (*Puccinia malvacearum* Mont.). Very common and the subject of many inquiries.

Horse-Chestnut

Leaf Blotch (*Phyllosticta paviae* Besm.). Less severe than usual.

Juniper

Rust or Cedar Apple. See Apple.

Lilac

Mildew (*Microsphaera alni* (Wallr.) Wint.). Abundant throughout the State.

Leaf Spot (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple

Tar Spot (*Rhytisma acerinum* (P.) Fr.). Occasional.

Leaf Spot (*Phyllosticta acericola* C. & E.). Common.

Anthracnose (*Gloeosporium apocryptum* E. & E.). Several records.

Leaf Scald (Physiological). Many complaints.

Winter Injury. Occasional.

Muskmelon

Wilt or Blight (*Bacillus tracheiphilus* Erw. Smith). Common and destructive in some cases.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common, but not severe.
MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common.

NASTURTIUM

LEAF SPOT (*Bacterium aptatum* B. & J.). One report.
ROOT GALLS (Nematodes). One record.

OAK

ANTHRACNOSE (*Gnomonia veneta* (Sacc. & Speg.) Kelb.). The *Gloeosporium* stage was sent in a few times.
MILDEW. Conidial stage.

OATS

SMUT (*Ustillago avenae* (Pers.) Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia triticina* Erik.). Common.
RUST (*Puccinia graminis* Pers.). Occasional.

OKRA

WILT (*Verticillium sp.*). Abundant in one locality and found in another.

PEA

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

PEACH

BROWN ROT (*Sclerotinia cinerea* (Bon.) Wor.). Common throughout the State. Severe on fruit in unsprayed orchards.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith and Townsend). Common. See Apple.
LEAF CURL (*Exoascus deformans* (Berk.) Fuckel). Abundant where the orchards were not sprayed.
SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of the spraying.
SHOT HOLE (*Phyllosticta circumcissa* Cooke). Common.
SHOT HOLE (*Bacterium pruni* Smith). Much more severe than usual. In some cases caused injuries similar to hailstone injury (Plate II; Plate III, fig. 1, 2).
POWDERY MILDEW (*Sphaerotheca pannosa* (Wallr.) Lev.). Occasional.
YELLOWS AND LITTLE PEACH. Much more severe than usual. Frequently causing heavy losses in well kept orchards which previously were comparatively free of disease.
WINTER INJURY. Several reports.

PEAR

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Common. See Apple.
LEAF BLIGHT (*Fabraea maculata* (Lev.) *Entomosporium* stage). Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.
LEAF SPOT (*Septoria pyricola* Desm.). Abundant.
BROWN BLOTCH (Cause undetermined). Abundant. Growers report that the treatment recommended in Circular 52 was thoroughly satisfactory.

PEONY

BUD ROT (Cause undetermined). Prevalent.

PEPPER

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in fall.
ROT (*Macrosporium sp.*). Common on fruits and also found on seeds. May have been secondary.
MOSAIC (Cause undetermined). Very severe and the cause of heavy losses (Plate IV, fig. 1).

PINE

ROOT DISEASE. This disease is evidently due to the attack of a root fungus resulting in a *Mycorhiza*. It is very destructive in the nurseries on pines and other coniferous stock grown under crowded conditions.

RUST (*Peridermium piriforme* Pk.). Common in Atlantic County and probably has a wider distribution. The *Cronartium* stage on *Comptoniae* was also collected in Atlantic County.

RUST (*P. acicolum* Und. & Earle). Common in Atlantic County.

RUST (*P. pini*). Was also collected in Atlantic County on *Pinus taedes*.

RUST (*P. strobi* Kleb.). The much feared European blister rust has been found in four localities in the State. Every possible effort is being made to eradicate it. (See rust on currant, p. 570, and also on p. 564.)

POPLAR

LEAF SPOT (*Marsonia populi* (Lib.) Sacc.). Common.

CANKER (*Dothichiza populea* S. & B.). Several reports of this disease were sufficiently urgent to necessitate special investigation. The disease was found to be very severe and destructive (Plate V, fig. 2).

POTATO

SCURF (*Rhizoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This very widely distributed disease was almost as severe as in 1915.

BLACK LEG (*Bacillus phytophthorus* Appel). This well known disease was less severe than usual.

SCAB (*Actinomyces chromogenus* Gast.). This disease was fully as severe as in past years.

RUSSET SCAB. A peculiar russeting was common in many parts of the State. It appears that this condition can be produced by the common scab organism or by *Rhizoctonia*.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). This disease was more abundant, but it cannot be said to be of much importance in the New Jersey crop. It is more important on the late than on the early crops (Plate IV, fig. 2).

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was not reported, but probably occurred in the mountainous districts.

ARSENICAL POISONING was reported from a few localities. It was always due to careless treatment.

TIP BURN. Very common, but there was less complaint this year than usual.

ROLL LEAF (Cause unknown). This disease was much more severe than usual.

MOSAIC (Cause unknown). Prevalent in some fields.

CURLY DWARF (Cause unknown). Frequent.

DODDER (*Cuscuta sp.*). Occasional.

PHLOX

POWDERY MILDEW (*Erysiphe communis* (Walh.) Schl.). Common.

PRIVET

ANTHRACNOSE (*Gloeosporium cingulatum* (Atk.) S. & S.). Several records. In one case killed a large number of cuttings.

PLUM

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the State.

BROWN ROT (*Sclerotinia cinerea* (Bon.) Wor.). Common throughout the State.

SHOT HOLE (*Phyllosticta circumscissa* Cke.). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

QUINCE

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe. See Apple.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Abundant and severe. See Apple.

RUST (*Roestelia aurantica* Peck). Occasional.

Raspberry

Anthracnose (*Gloeosporium venetum* Speg.). Abundant and destructive.

Crown Gall (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. See Apple.

Leaf Spot (*Septoria rubi* West.). Abundant.

Cane Blight (*Coniothyrium fuckelii* Sacc.). Very abundant and destructive. The cause of an increasing number of complaints.

Spur Blight (*Glomerella rubicola* (Ston.) E. & E.). One report.

Rose

Crown Gall (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Frequent.

Anthracnose (*Gloeosporium rosae* Hals.). Common, but not serious.

Leaf Blotch (*Actinonema rosae* (Lib.) Fr.). Common and very severe in the greenhouse.

Powdery Mildew (*Sphaerotheca pannosa* (Wallr.) Lev.) Common, and more severe than usual.

Leaf Spot (*Phyllosticta rosicola* Massal.). Abundant and frequently confused with black spot.

Cane Blight (*Coniothyrium fuckelii* Sacc.). Common and the cause of many complaints.

Snapdragon

Anthracnose (*Colletotrichum anthirrhini* Stew.). Occasional.

Rust (*Puccinia anthirrhini* D. & H.). Two records.

Stem Rot (*Sclerotium*). One record. Very destructive.

Squash

Mosaic (Cause undetermined). One record. A peculiar mottling of the leaves, characteristic of the disease on other plants. No insects present.

Strawberry

Leaf Spot (*Mycosphaerella fragariae* (Tul.) Lindau). Common.

Leaf Spot (*Ramularia tulasnei* Sacc.). Common.

Leaf Spot (*Marsonia potentillae* (Desm.) Fisk). Frequent.

Winter Injury. Frequent.

Powdery Mildew (*Sphaerotheca humuli* (D. & C.) Burr.). One report Very destructive.

Sweet Potato

Black Rot (*Sphaeronema fimbriatum* (E. & H.) Sacc.). Abundant, but not so severe as in 1915.

Wet Rot (*Rhizopus nigricans* Ehr.). Common in storage, but readily controlled by ventilation.

Stem Rot or Yellow Rot (*Fusarium batatatis* Wollen). Common, but not so destructive as in 1912.

Rot (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.

Charcoal Rot (*Sclerotium bataticola* Taub.). Frequent.

Rot (*Trichoderma koenigii* Ould.). Common.

Rot (*Melanospora globosa* Berl.). Common. May have been secondary.

Rot (*Penicillium sp.*). Common. May have been secondary.

Scurf or Soil Stain (*Monilochaetes infuscans* E. & H.), Common.

Sycamore

Anthracnose (*Gnomonia veneta* (Sacc. & Speg.) Kleb.). Very abundant.

Tobacco

Mosaic (Cause undetermined). One record.

TOMATOES

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). A few reports.
FRUIT ROT (*Macrosporium solani* (E. & M.). Abundant.
STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.
BLOSSOM END ROT (Cause questionable). Common.
LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and very severe in some localities.
MOSAIC—Filiform Leaf (Cause undetermined). Very abundant in many localities. No doubt the cause of heavy losses.

WALNUT

LEAF SPOT (*Marsonia juglandis* (Lib.) Sacc.). Abundant.
YELLOWS (Cause undetermined). Two records.

WATERMELON

ANTHRACNOSE (*Colletotrichum lagenarium* (Pass.) E. & H.). Abundant in southern part of the State.

WHEAT

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Common. (*Puccinia rubigo-vera* (DeC.) Wint.). Common. *Puccinia triticina* Errh.). Common.
SMUT (*Tilletia foetens* (B. & C.) Trel.). Frequent. (*Tilletia tritici* (Bei.) Wint.). Abundant.
SMUT (*Ustillago tritici* (Pers.) Jens.). Common.
MOLD (*Cladosporium herbarum* (Pers.) Lk.). Occasional.

WILLOW

LEAF SPOT (*Gloeosporium salicis* West.). Common.

Many other diseases on ornamental and on cultivated plants were found and recorded which are not included in the preceding list. Some of them will be described in the "Parasitic Fungi of New Jersey."

XI

TOMATO SPRAYING EXPERIMENTS AT SALEM, NEW JERSEY

WILLIAM H. MARTIN

Introduction

The importance of the tomato-growing industry in New Jersey, and the losses resulting from attacks by fungous diseases, has led the Department of Plant Pathology to conduct experiments for the control of these diseases. While numerous parasitic fungi attack the tomato, comparatively few do much damage in this State. The disease most widely distributed and causing the most serious losses is the late blight. This disease is caused by the fungus *Septoria lycopersici* Speg. It is difficult to estimate the losses resulting from attacks of this fungus, but in this State it probably does more damage than all the other diseases of the tomato.

The disease was first reported for the United States by Dr. B. D. Halsted from this State (1896–'97). Since then it has become common wherever tomatoes are grown. It is known by various names in different sections of the country, but in New Jersey it is usually termed "late blight" to dis-

tinguish it from the less serious "early blight" (*Macrosporium solani* E. & M.).

The disease is commonly found on the leaf and stem, but it also appears on the calyx, and is reported by Norton[1] as doing damage to the fruit. In New Jersey, however, the injury to the fruit is negligible. On the stem and leaf the disease does its greatest damage. On the leaf the disease first appears as small water-soaked spots; these spots gradually enlarge to about a quarter of an inch in diameter and usually become circular or oval in outline. The mature spots are greyish-white in color, and, in many instances, have a distinct purplish border. Very frequently the spots may coalesce and the entire leaf will present a dead appearance. It is characteristic of the disease that these dead leaves remain attached to the plant. The disease usually attacks the leaves at the base of the plant and works toward the tip of the stem, only a few green leaves remaining at the apex of the branches in advanced stages.

On the stem elongated spots appear; these are not as well defined as the spots in the leaves, but are quite prominent. While the disease does not do as much damage on the stem as it does on the leaves, it is serious, in that the spots on the stem may serve as infection centers.

The disease is favored by moist weather, and under favorable conditions it progresses rapidly, spreading over a field in a short time.

Field Tests

During the summer of 1916 experiments were conducted on the farm of Miss Jennie Waddington, near Salem, New Jersey. The work was done in coöperation with the Office of the Cotton, Truck and Forage Disease Investigation of the United States Bureau of Plant Industry, and the H. J. Heinz Company, of Pittsburgh, Pa.

The experiment was designed to determine (1) to what extent late blight could be controlled by spraying with Bordeaux mixture; (2) the best strength Bordeaux mixture to be used, and (3) the proper time to make the applications. It was not expected that answers to all these questions could be obtained in a single season, but it is hoped that these experiments will be continued for a sufficiently long period to get accurate results, that is, to eliminate as far as possible the differences resulting from variations existing in climatic conditions of various seasons.

The plants used in this experiment were of the "Trophy" variety. The low yields, as will be brought out later, may be attributed to several causes. Shortly after the plants were set in the field a large number were completely defoliated by potato bugs, others wilted and died before they could become established. This necessitated the resetting of a large portion of the field, and as a result the plants were three weeks late in getting started. Another factor that was partly responsible for the low yield was a severe hailstorm at the time the fruit was setting.

Three strengths of Bordeaux mixture were used in this work: (1) 4 pounds of copper sulfate and 4 pounds of lime to 50 gallons of water; (2)

[1] Norton, J B. S., Tomato Diseases, Md. Agr. Exp. Sta. Bul., pp. 102–114, 1914.

2 pounds of copper sulfate, 3 pounds of lime to 50 gallons of water; (3) 6 pounds of copper sulfate, 4 pounds of lime to 50 gallons of water. In all there were seven different treatments, as follows:

Plot I. One application of the 2-3-50 Bordeaux mixture in the seed-bed and 5 applications of the 4-4-50 formula in the field on the following dates, June 23, July 6, July 18, August 7 and August 21.
Plot II. Sprayed with 4-4-50 Bordeaux mixture June 23, July 6, July 18, August 7 and August 21.
Plot III. Sprayed with the 4-4-50 Bordeaux mixture, July 18, August 7 and August 21.
Plot IV. Sprayed with the 4-4-50 Bordeaux mixture July 6, July 18, August 7 and August 21.
Plot V. Sprayed with the 2-3-50 Bordeaux mixture June 23, July 6, August 7 and August 21.
Plot VI. Sprayed with the 6-4-50 Bordeaux mixture June 23, July 6, August 7 and August 21.
Plot VII. Sprayed with the 4-4-50 Bordeaux mixture June 23, July 6, July 18 and August 7.

It was intended to spray Plots V and VI on the same dates as Plots I and II, but this was made impossible by a break in the spray engine and the July 18 spray was necessarily omitted. This also accounts for the long interval between the third and fourth application in the other plots.

In plot work it is recognized a necessity to control as much as possible the differences resulting from soil variation. This can be done only by a sufficient number of repetitions and by the use of check plots. In this work there were three repetitions of each treatment. The arrangement of the plots was as follows: A check, two treatments and a check. This was continued throughout a series and the series was repeated three times. This arrangement gave 12 check plots and 21 spray plots, or 33 plots in all. In order that the spraying be done on a commercial scale each of the 21 spray plots was made a little more than one-fourth of an acre in size. In getting the yields it was found necessary to reduce the size of the plots to one-eighteenth of an acre. The plants were set 4 x 4 feet, so that each plot, as harvested, consisted of 150 plants. The general plan was to make each plot 5 rows wide for spraying and take yields from the three middle rows, the two outer rows being used as buffer rows, and as such were discarded.

Table I gives the arrangement of the plots as they occurred in the field. It must be remembered, however, that the three series were continuous, that is, extended the length of the field and were not divided into sections as indicated in the table.

This table also gives the yield in tons per acre from each plot. It will be noticed that in different sections of the experimental area, plots having the same treatment vary considerably. This cannot be avoided for soil variations are certain to occur in an experiment extending over so great an area. By repeating a treatment and its check three times the difference resulting from the average will give a fairly accurate measure of the benefit derived from the treatment in question.

Table I

Arrangement of Plots in Tomato-Spraying Experiment, with Yield Per Acre for Each Plot

Plot	Treatment	Yield Per A, Tons	Plot	Treatment	Yield Per A, Tons	Plot	Treatment	Yield Per A, Tons
1	Check, ...	2.814	12	4-4-50, ... Seed-bed Aug. 21	5.521	23	4-4-50, ... Seed-bed Aug. 21	4.624
2	4-4-50, ... Seed-bed Aug. 21	4.588	13	Check, ...	2.941	24	4-4-50, ... June 23 Aug. 21	4.135
3	4-4-50, ... June 23 Aug. 21	4.706	14	4-4-50, ... June 23 Aug. 21	5.104	25	Check, ...	2.543
4	Check, ...	3.670	15	4-4-50, ... July 18 Aug. 21	4.000	26	4-4-50, ... July 18 Aug. 21	3.303
5	4-4-50, ... July 18 Aug. 21	5.493	16	Check, ...	2.787	27	4-4-50, ... July 18 Aug. 21	3.356
6	4-4-50, ... July 6 Aug. 21	4.724	17	4-4-50, ... July 6 Aug. 21	4.316	28	Check, ...	2.624
7	Check, ...	3.755	18	2-3-50, ... June 23 Aug. 21	3.855	29	2-3-50, ... June 23 Aug. 21	3.665
8	2-3-50, ... June 23 Aug. 21	5.502	19	Check, ...	2.841	30	6-4-50, ... June 23 Aug. 21	4.316
9	6-4-50, ...	5.710	20	6-4-50, ... June 23 Aug. 21	4.163	31	Check, ...	3.402
10	Check, ...	4.172	21	4-4-50, ... June 23 Aug. 7	4.108	32	4-4-50, ... June 23 Aug. 7	4.766
11	4-4-50, ... June 23 Aug. 21	5.927	22	Check, ...	2.597	33	Check, ...	3.122

Manner of Application of the Spray

For this work a gasoline power sprayer was used. This was furnished by the Cotton, Truck and Forage Disease Laboratory of the United States Bureau of Plant Industry. The outfit was a two-wheel, two-horse cart with a 100-gallon tank. It carried two lines of hose each 25 feet long and each hose was equipped with a 5-foot iron extension rod. Each rod was fitted with a single nozzle. Each extension was provided with a cut-off valve at the

base, so that in case the nozzle became clogged, the spray could be shut off without stopping the engine. A pressure of approximately 150 pounds to the square inch was maintained. This gave a fine mist that proved very satisfactory. The spray was applied at the rate of 100 gallons to the acre. This was found to be sufficient to cover each plant thoroughly and evenly.

Table II

Relation of Spraying to Yield and Profit

Plot No.	Treatment With Adjacent Checks	Yield Per Acre, Average of 3 Repeats		Increase Due to Treatment		Cost of Spraying, Per Acre	Value of Increased Ripe Fruit	Net Profit Per Acre	Cost of Spraying with $CuSO_4$ at Normal Price	Net Profit Normal Year
		Ripe Fruit Tons	Green Fruit Tons	Ripe Fruit Tons	Green Fruit Tons					
	Check, ...	2.784	.060	.....	.....	.....	.....	.....	.....	.....
1	4-4-50, Seed-bed, June 23, July 6, 18, Aug. 7, 21, ...	4.911	.349	2.127	.289	$13.77	$21.27	$7.50	$7.77	$13.50
2	4-4-50, June 23, July 6, 18, Aug. 7, 21, ..	4.648	.228	1.597	.147	13.77	15.97	2.20	7.77	8.20
	Check, ...	3.051	.081	.....	.....	.....	.....	.....	.....	.....
	Check, ...	3.000	.099	.....	.....	.....	.....	.....	.....	.....
3	4-4-50, July 18, Aug. 7, 21, ...	4.265	.302	1.265	.203	8.25	12.65	4.40	4.65	8.00
4	4-4-50, July 6, 18, Aug. 7, 21, ...	4.124	.301	1.069	.199	11.17	10.69	0.48	6.20	4.49
	Check, ...	3.055	.102	.....	.....	.....	.....	.....	.....	.....
	Check, ...	3.066	.085	.....	.....	.....	.....	.....	.....	.....
5	2-3-50, June 23, July 6, Aug. 7, 21, ...	4.340	.244	1.274	.159	7.53	12.74	5.21	5.04	7.70
6	6-4-50, June 23, July 6, Aug. 7, 21, ...	4.729	.247	1.248	.142	14.69	12.48	2.21	7.36	5.12
	Check, ...	3.481	.105	.....	.....	.....	.....	.....	.....	.....
	Check, ...	3.283	.105	.....	.....	.....	.....	.....	.....	.....
7	4-4-50, June 23, July 6, 18, Aug. 7, ...	4.822	.358	1.539	.253	11.17	15.39	4.22	6.20	9.19

The spray plots were arranged in such a way that there was a roadway between each two treatments. The spray machine was driven over the same row each time and in the same direction to keep an open alley. The five rows on each side of the roadway constituting a plot.

This method of spraying proved very satisfactory. Little, if any, more time is taken to spray with an outfit of this kind than with the ordinary traction or gasoline power sprayer. More labor is required as one man is needed to drive and two men are required to spray, one man on each side

of the spray machine. The length of the hose enables each man to spray 5 rows on each trip through the field. This, with the row that is driven over, makes 11 rows in all. By this method, with careful operators, both surfaces of every leaf are covered with a film of the mixture; another advantage in favor of the method is the fact that to spray 11 rows it is necessary to drive over but one. This row was discarded in obtaining yields, as well as the two outside rows of each plot, as was previously indicated.

The data secured from the experiment at Salem are tabulated in Table II.

It will be noted that the yield of green fruit is greater in the sprayed plots than in the unsprayed plots. This is not thought to be due to the spray but is attributed to the late start made by the plants. This increased green fruit only tends to show that the sprayed vines remained vigorous for a longer period than the unsprayed vines. In calculating the value of the increase from the sprayed plots the green fruit was not included.

A study of Table II shows at once that the first plot, namely, the one receiving one application in the seed-bed, gave the highest returns. There was an increase of 2.127 tons of ripe fruit and 0.349 tons of green fruit over the adjoining checks. It must be noted in this connection that the average of the check plots, 2.739 tons, is well below the average yield. However, it is safe to assume that with a normal yield, while the per cent increase would not have been so large, the difference would have been more striking. While this treatment was not wholly successful in combatting the blight, the plants presented a better appearance than those of the adjoining checks.

While there was an increase of 75 per cent over the check plots, the net returns are not as great as they would be under normal conditions. The price of copper sulfate was 300 per cent higher than normal and this nearly doubled the cost of spraying. The following table gives the cost of making 5 applications of 4-40-50 Bordeaux mixture at the rate of 100 gallons to the acre.

500 gal. Bordeaux mixture @ $1.80 gal.,	$9.00
815 min. (horse) @ 15c per hr.,	2.00
815 min. (man) @ 17.5c. per hr.,	2.36
Depreciation of outfit,	.25
Gasoline,	.16
Total,	$13.77

This includes all the time occupied in preparing the stock solutions, filling the spray tanks and driving to and from the field.

In estimating the cost of this treatment no account has been taken of the cost of the one application in the seed-bed. This, however, is so small as to be considered negligible.

The value of the increase from spraying is estimated in the basis of $10 a ton, this being the price paid by canneries. At this rate the value of the increase is $21.27, giving a net return of $7.50 an acre.

Plot II. In this plot the application in the seed-bed was omitted, the plants were sprayed in the field with the 4-4-50 mixture on the same dates

as Plot I. The increase resulting from the treatment was 1.597 tons of ripe fruit and 0.147 tons of green fruit. The net returns were $2.20 an acre.

Plot III was also sprayed with the 4-4-50 mixture, the applications on June 23 and July 6 being omitted. The increase of 1.265 tons of ripe fruit and 0.203 tons of green fruit is below the average from Plots I and II. The net return from this plot was $4.40 an acre. This increase over the returns from Plot II is explained by the lessened cost of applying the three sprays.

Plot IV was sprayed 4 times with the 4-4-50 mixture, the spray of June 13 being omitted. The increase is not as large as that noted for Plot III, but it is approximately the same, being well within the experimental error. The value of the increase was 10.69 cents. A loss of 48 cents an acre resulted from this treatment.

Plot V was sprayed with the 2-3-50 Bordeaux mixture on the same dates as Plots I and II, with the exception that the spray on July 18 was omitted. This was made necessary by a break in the spray engine. The increase from this treatment was slightly larger than that from either Plots III or IV. An increase of 1.279 tons of ripe fruit and 0.159 tons of green fruit was obtained. The net returns, $5.21 an acre, were greater than from any of the treatments with the exception of Plot I. This may be accounted for by the low cost of the 2-3-50 mixture.

Plot VI. The plot was sprayed with the 6-4-50 mixture on the same dates as Plot V. The increase was about the same for both plots, but there was a loss of $2.20 per acre due to the greater cost of the 6-4-50 mixture.

Plot VII. This plot was also sprayed with the 4-4-50 mixture. The dates of the application were the same as for Plots I and II, with the exception of the spray on August 21, which was omitted. The increase of this treatment over its adjacent checks was 1.539 tons of ripe fruit and 0.253 tons of green fruit per acre with net returns of $4.22 per acre.

Summary

While none of the sprays experimented with gave very complete control of the late blight, it will be seen from Table II that in every treated plot, Bordeaux mixture gave increased returns, regardless of the time of application or the strength of the spray. The check plots were seriously affected with the late blight, while the sprayed plots were less seriously affected and presented a better appearance throughout the season. The plants that were sprayed in the seed-bed made a much more vigorous start than any of the unsprayed plants. This cannot be said to be due to the control of disease, as there was little present in the unsprayed plants so early in the season. The presence of the spray, of course, protected the young plants from insect attack, for while Bordeaux mixture is not an insecticide, the spray acts as a repellant to insects.

From the present season's work it would appear that the most desirable spray mixture is the 4-4-50. It is worthy of note in this connection that

four applications of the 2-3-50 spray gave almost as large returns as five applications of the 4-4-50 mixture. The 2-3-50 formula would be highly desirable if it would serve to protect the plant from fungus attacks for several reasons. (1) This low strength mixture would eliminate any possible spray injury to the plants. (2) The low cost of the materials in the spray is a big factor in its favor. More work, however, must be done before its adoption can be recommended. For the present, it appears that the 4-4-50 mixture could be expected to give best results.

While no definite time of applying the spray can be stated from the data secured, the results tend to favor the early applications. In considering the 4-4-50 treatments they might well be divided into two classes, those receiving early and those receiving late applications. That is, three plots received the first application on June 23, while the other two were first sprayed in July 6 and July 18, respectively. Those receiving the earlier applications gave increased returns of 57 per cent over the adjoining check plots, while the two plots receiving the later treatment gave an increase of 38 per cent over the checks. This shows a 19 per cent increase in favor of the early applications. As has been pointed out the plot receiving one application in the seed-bed gave best returns, there being an increase of 73 per cent over its checks. This is an increase of 21 per cent over the plot that received five applications of the 4-4-50 treatment in the field on the same dates as the former plot. It appears, therefore, from the increased yields from the plots having the early applications that the ideal treatment would be to spray at least once in the seed-bed, though every week would be more desirable, and to make applications in the field at intervals of 10 days or 2 weeks, beginning as soon as the plants are established.

The good results with spraying do not stop with an increased yield. The fruit from sprayed vines is a much better color and more solid than fruit from similar unsprayed vines. These two qualities are highly desirable for cannery tomatoes.

Some of the growers for early market have raised the question as to the influence, if any, the spray has in the ripening period. The results secured throw no light on this question as far as the early market is concerned, but there is little doubt that spraying has little, if any, influence on the time of ripening of tomatoes for the late market or the cannery. This is shown in figure 1. Here the abscissas are taken arbitrarily to represent the dates of picking and the ordinates represent the pounds per acre from each picking. As is shown in figure 1, there result two graphs, the upper one representing the yields from the sprayed vines and the lower the yields from the unsprayed vines.

From figure 1 it is at once clear that there was no difference in the ripening period of the fruit from sprayed and unsprayed vines. The only points the graphs tend to diverge are towards the end of the season when the graph representing the yield from the sprayed vines is uniformily higher. This is to be expected since the vitality of the sprayed vines was, no doubt, prolonged, due to the protection afforded them from fungous attacks.

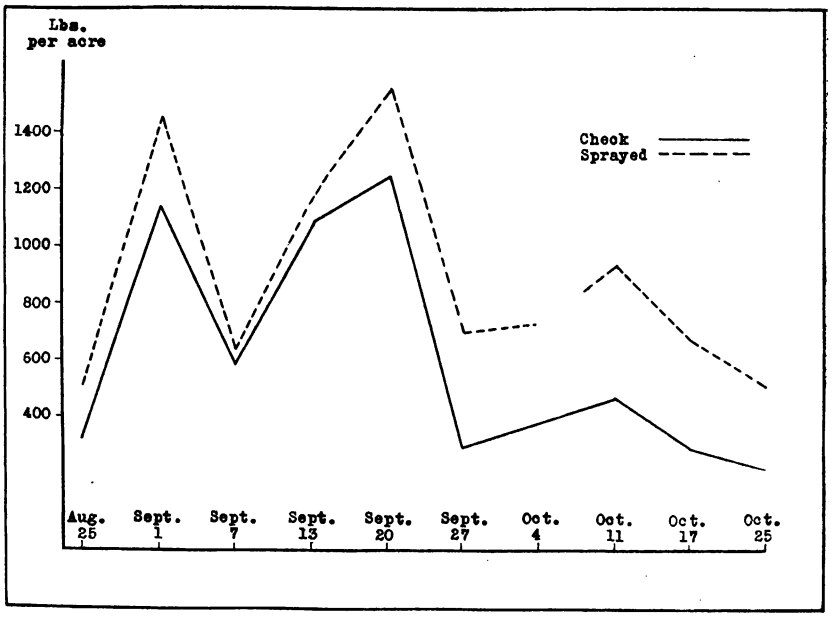

Fig. 1.—Curves showing yields of tomatoes in spraying experiments.

Conclusions

The following conclusions are tentative only, being based on but one year's work.

1. While the sprays employed did not give complete control of the blight, the increased returns will warrant spraying.
2. The 4-4-50 mixture gave best results.
3. The 2-3-50 gave good results and is worthy of further trial.
4. The high cost of the 6-4-50 mixture prohibits its use.
5. The best time of application is one or more treatments in the seed-bed, followed by applications every week or 10 days in the field.
6. The present work would indicate that the early sprays are the most important.
7. The fruit from sprayed plants was a better color and firmer than that from similar unsprayed vines.
8. Spraying has no influence on the ripening period.
9. The sprayed plants remained vigorous for a longer period than the unsprayed.

XII

REPORT ON DISEASES OF CELERY

W. S. KROUT

Foreword

The following report covers the field work done by the New Jersey Agricultural Experiment Station on the principal celery diseases of the State. All the work was conducted on the farms of Tunis Drenth, Ernest Spell, Drenth Bros., and Henry Kuiper, in the Oradell-Ridgewood celery region in Bergen County, with the exception of a few spray experiments conducted on Mr. Charles Hillman's farm, near Paterson; on Mr. James Nelson's farm near New Brunswick; and on the New Jersey Agricultural Experiment Station farm. The work covers the time between August, 1915, and November, 1916. All data are based on the work done in the Oradell-Ridgewood celery region unless otherwise specified.

Until about fifteen years ago this region was practically unknown to the celery grower. At that time some of the Holland celery growers of the Great Meadow celery region in Warren County discovered this acre of diamonds in the celery world, which was then a primitive peat bog covered with a flora characteristic of its kind, and made investments in it.

The writer wishes to express his thanks to Dr. Mel. T. Cook, in whose department the work was done, to Dr. J. G. Lipman, Director of the New Jersey Agricultural Experiment Station, and to Prof. A. W. Blair, for the many helpful suggestions received during the work. Also, much credit is due Mr. L. F. Merrill, the Bergen County farm demonstrator, for making arrangements with the farmers whereby the work was made possible, and for other coöperation.

Laboratory work is being done upon each of the organisms mentioned in this article, and will be discussed later in another publication.

Objects

The object of the experiments may be briefly summarized as follows:

(1) A safe, simple and economical way of destroying diseases of the greenhouse injurious to celery seedlings.

(2) A control of the *crown rot* disease by the application of various chemicals and field steam sterilization.

(3) Spraying for *early* and *late blight* of celery under which the following points were considered: (a) the cheapest and most efficient spray material to use; (b) the proper strength of each material; (c) how to make and prepare the spray economically, rapidly, accurately and efficiently; (d) weather conditions in relation to the frequency of spraying; (e) the proper time to begin spraying for each disease.

(4) Factors involved in the spreading of the blight organisms from plant to plant and from field to field, and the wintering of the organism.

I. Prevailing Conditions of the Region

Acreage—The acreage is not large at present; only about 300 acres are under actual cultivation; from 400 to 500 acres more are possible. Many companies and individuals are now actively at work bringing this land under cultivation.

Soil—The soil is of peat origin and varies in depth from 9 feet on the east and west sides to 29 feet near the middle. A heavy turf, which covers the surface of all primitive soil, must be removed before cultivation is possible; generally 2 to 4 years is necessary before celery can be expected to produce a maximum crop.

Land Prices—To bring an acre of this peat bog into production costs between $175.00 and $300.00. As a result, improved land sells at $500.00 to $1,000.00 per acre.

Water Table—The region has an ideal water supply as two never-failing brooks run through the middle of the acreage. By letting out or damming up the water in these brooks the water table can be lowered or raised in the most of the fields. Thus in a drought, celery flourishes here while it is firing on the uplands.

Climate and Weather—The climate is typical of the temperate zone with the exception of an excess of moisture. From July 1 to October 1 heavy fogs occur during the night and extend far into the forenoon of each day.

Rains are frequent throughout the summer. The winds are variable, but are usually from the west.

Rotation—Rotation of crops is seldom practiced unless the soil becomes infected with some organism. A rotation of celery for one year and corn for two years; celery, clover and onions; lettuce and celery has been tried upon soil infected with crown rot trouble. None of these rotations gave any relief.

Chemical Relation of the Soil—This soil being of a peat origin is naturally very acid in reaction to litmus. Very little lime has been applied by most of the growers. One grower, who made a limited application this spring to a small acreage, increased his crop approximately 7–5. To avoid injury to the soil by oxidation, chemical determinations are being made to ascertain just how much lime is needed. Studies indicate that from 1,500 to 2,000 pounds of air-slaked lime, $Ca(OH)_2$, might safely be added per acre without detrimental results. However, larger quantities of ground limestone or ground oyster-shell may be added.

Potash is another limiting factor. None was applied to the soil, aside from the plots, during the past year except what came in through organic manures.

The Station has three 1–96 acre plots to which potash was applied at the rate of 1,000 pounds per acre. They all showed increased yields. With this apparent increased production due to the use of lime and potash, the growers and the Station are planning a more extensive series of experiments for the following year both as to the effect of these fertilizers combined and separately. The aim is to increase the vitality of the plants and thus increase its resistance to the organisms of disease.

Celery Culture—The cultural methods of this region are among the most intense on record for celery as three crops are grown throughout the year. Seedlings are grown in hothouses for the first crop, and set in the field from April 7 to May 10, or as soon as the soil is workable. The rows for the first crop are planted from 20 to 30 inches apart. From June 9 to 25 the second crop is planted between the first crop rows. The first crop is harvested from June 20 to July 10, and a third crop planted in every other row that was harvested. The third crop is harvested anywhere from October 1 to January 1. All blanching is by means of boards except with the last crop, which is blanched by earth.

II. Hothouse Experiments

Celery seedlings are very delicate and extremely difficult to grow in the hothouse unless the best of care is given them. One of the most important factors in their growth is the soil. Every grower knows that it takes from 2 to 3 years of consistent work to develop what is considered a good seed-bed soil. Generally, by the time he has this soil improved to the desired tilth, parasitic enemies, such as bacteria and fungi, appear in such numbers as to destroy the plants. Houses were found in which the soil had not been changed since they were first constructed some three to six years ago. The method of replenishing the soil is by the use of organic manures and commercial fertilizers.

Troubles of Houses Previous to Beginning of the Work—This method of handling the seed-bed led to infection. The main trouble was a yellowing of the young plants, similar to that of the crown rot which will be described later. Any time after the production of the fifth leaf the seedling was subject to attack. The symptoms were as follows:

At first a slight yellowing on one side of the seedling. Two to four weeks later the entire plant would be yellow or dead. Only a bacterium species and fusarium species could be isolated from these plants by the sterile tissue method. "Damping off" gave some trouble, but was not serious.

Two of these hothouses which had the above-mentioned troubles, one (No. 1) on the farm of Tunis Drenth, and the other (No. 2) on the farm of Ernest Spell, were taken over by the Station and treated as explained in the following paragraphs:

Cleaning, Spraying and Changing of Soil in Hothouse No. 1—The work was started in this house November, 1915, by emptying and sweeping out all the beds except an 8-foot end of a 3-foot side bed which was left for for formalin treatment. Then the house was sprayed with a 5-6-50 Bordeaux mixture. This was carefully done so as not to leave a square inch of the inside of the house untouched by the spray. The house was closed for two weeks. Two-tenths of a pound of burnt limestone to the cubic foot of soil was then thoroughly worked through this seed-bed soil.

Formalin Plots—Twenty-four square feet (previously referred to) of the old contaminated soil of the greenhouse was placed at one end of a 3-foot side bed. Next to this, but separated by a tight board partition, was placed 96 square feet of clean soil.

Formalin Treatment of Plots—To these plots was applied one gallon of a 3.25-50 formalin solution to each square foot of surface. Immediately after applying the formalin solution, the soil was covered with several thicknesses of old carpet and old fertilizer sacks, which thus helped to hold the fumes in the soil and thus increase its disinfecting power. This covering was removed two days after the application. To facilitate drying, and aid the fumes in passing from the soil, it was stirred on the third and sixth days after the drenching. The soil lay from 5 to 6 inches deep in the bed, and dripping was very prevalent from the bottom of the bed when 100 gallons of the solution had been applied to the 120 square feet of surface. To see if the bottom layer of the soil was as well saturated as the top, a portion of the soil was inverted, and the lower end was found to be well saturated and giving off characteristic formalin fumes. As muck soils absorb large quantities of any solution, it was approximately half saturated with water before the formalin solution was applied. This is an important factor, and determines how much of the formalin will be retained by the soil before dripping occurs. After the bench is dripping freely at all parts of its bottom, it is a waste of material to apply more of the formalin solution. With muck soil, previously one-half saturated, it undoubtedly would have been better to have used 7.5 pounds of formalin to 100 gallons of water instead of the same amount to 120 gallons.

Sowing of Seed—Three plots of 3 square feet each were laid off on the old soil treated with formaldehyde for the purpose of testing just when celery seed could be sown without sustaining injury from the formalin. The formalin solution was applied February 28. Approximately, the same amount of seed was sown upon each plot, 3, 7 and 11 days subsequent to the application of the formalin. Seed was sown on the remaining 111 square feet 11 days after the application in order to make a comparison of plants grown on both kinds of soil after the treatment.

Effects of Formalin on Seed Germination—Seed sown 3 days after the application germinated approximately one-half as well as those sown 7 days after. Those sown 11 days after the application germinated approximately two-thirds as well as those sown 7 days after.

This part of the experiment shows: (a) that the 3-day period prevents some of the seed from germinating; (b) that the 7-day period is the proper time to sow celery seed in order to get a maximum stand of plants; (c) that formalin has its maximum stimulating effect upon celery seed germination when the seed are sown at the end of the 7-day period.

Effect of Formalin Upon the Subsequent Growth of the Plant—Frequent observations were made upon the plants throughout their seed-bed growing period. The plants in the 3-day plot were much scattered, but showed few weak-looking seedlings which would seem to indicate that the formalin permitted only the seed of strong vitality to germinate.

The 7-day plot had more stocky-looking plants for the first five weeks than either of the other two. After this, due to their crowded condition, the plants became less stocky and grew rapidly. The 11-day plot grew rapidly, but failed to equal those in the 7-day plot.

Formalin Experiments in Hothouse No. 2—After seeing the disinfecting power of formalin upon the soil house No. 1, and at the request of Mr. Spell, a neighbor grower, who lost this spring practically his whole house of first-crop celery seedlings, a more careful and extensive series of experiments were planned in order to verify the experiment in house No. 1.

Briefly outlined the experiment ran as follows:

A portion of the seed-bed containing badly contaminated soil was chosen. This was divided into 8 plots containing exactly 3 square feet each. Seven of these plots were treated with a 3-25-50 formalin solution after the same manner as those in house No. 1. The one plot was untreated and served as a check; 0.77 gm. of seed was carefully weighed out for each plot. Plot 1 was sown forty hours after the application. Plots 2 to 8 were sown at 2-day intervals after Plot 1.

Results from Formalin Treated Plots in House No. 2—This experiment verified all results obtained in house No. 1. In addition it showed (a) that the most viable seed would germinate in a formaldehyde soil 40 hours after the application; that there was a gradual increase in the number of germinated seeds until the maximum was reached in the 7-day plot; that the seedlings in the formalin-treated plots were healthy, whereas in the check three-fourths of them died.

Fertilizers for Hothouse Plants—Celery seedlings are very sensitive to unfavorable environments. If the proper nutrition is not in the soil the plant weakens and is soon attacked by parasitic organisms. The plants in these two houses were carefully watched and as soon as they were noticed to be on the decline an application of nitrate of soda, at the rate of 0.03 of a pound to the square foot of surface was applied over the entire house. In addition dried blood and potash (KCl) were applied to certain plots. These fertilizers soon brought the seedlings back to their proper state of growth.

Spraying the Hothouse—Although neither the early nor late blight appeared on the seedlings, they were sprayed March 31 and April 11 with a 3-4-50 Bordeaux mixture. Due to the waxy secretion of the leaf, the spray had a tendency to collect at the base of each leaflet. This was overcome by the application of 3 to 4 pounds of laundry soap to 50 gallons of the spray.

Bordeaux seemed to act as a stimulant. The line of demarcation between sprayed and unsprayed plots was indicated by an abrupt offset. Measurements were made April 20 on a large number of plants in both sprayed and unsprayed plots. The spray seedlings showed an average increase in height of 0.31 inches over those in the checks.

III. Crown Rot In the Field

Occurrence—This disease has been prevalent in this region for over ten years. It started in a plot of ground that had a very heavy vegetation of fern growth previous to the clearing. From this center of infection it has spread outward until it is now found more or less on nearly every farm in this region.

Organism—The causal organism apparently is a soil bacterium or a bacterium and fusarium working simultaneously. At the present time the writer refrains from a further discussion of the organism until further studies have been completed.

Disease—The organism upon its first entrance into the plant through one or several of the main side roots gives the vascular system in the roots and crown a yellowish-brown appearance. Once in this system, it spreads out laterally, rotting the adjoining tissues. As a result of the above method of progress of the organism two or three of the leaves on one side of the plant are at first observed to be yellowing. This spreads to the entire foliage in from 2 to 4 weeks, causing a gradual dying of the plant.

Varieties Susceptible—The organism mainly affects the Golden Self-Blanching celery, making it impossible to grow the main commercial variety. The new Easy Bleacher celery partially solved the problem for this year, as it is partially resistant to the organism and brought the same price as the Golden Self-Blanching. The green stem varieties are entirely resistant, but are undesirable as a commercial crop for the entire year.

Object—The object of the experiment briefly outlined was as follows:

1. To find the germicidal values of various chemicals toward the crown rot organism.

2. To see if certain compounds would stimulate the plant to such an extent that it becomes resistant to the organism.

3. To discover the effect these chemicals in varying amounts might have upon the growth of the celery plants.

Plot Project—Table III shows the arrangement of the chemically treated plots and the amounts applied. All plots were 30 x 15 feet, except Plots 1 and 2, which were 5 x 15 feet. Two different locations were used in order to have all plots in the worst contaminated soil.

Results—Golden Self-Blanching celery was planted in each plot for the first and second crops. Due to healthy plants from the treated hothouse and exceptionally favorable weather conditions the first crop was partially free from the disease. The second crop was severely attacked and most of it was lost.

Formalin (CHOH)—This was applied a few days after the spring plowing. Forty per cent formalin applied at the rate of 3,000 and 4,608 pounds per acre gave a partial control for the second crop. At 8 cents per pound, this would cost from $240 to $368.64 per acre.

That formula applied at the rate of 3,000 pounds per acre is very toxic to celery seedlings is shown by the following results: One dozen seedlings were placed in soil, as above treated, each day after the application, for 13 successive days. All plants died inside of a few hours until the eighth day, when 2 out of a dozen lived for one day. Each succeeding day's planting showed that the toxicity was gradually passing out of the soil by the fact that more plants lived the longer the time was extended. On the tenth day the soil was thoroughly stirred by spading and the plants set on the thirteenth day. Approximately 90 per cent of the thirteenth day planting lived.

Table III

Arrangement of Plots in Experiment on Control of Rot

Plot 1. $CaCl_2$ 5 lbs. Plot 2. $FeSO_4$ 3 lbs. Plot 3. $CuSO_4$ 0.3 lbs.	Plot 3. Check Untreated.	Plot 4. Ferrous Sulphate 3 lbs.	Plot 5. Formalin 27 lbs.	Plot 6. Check Untreated	Plot 7. Sulphur 10.4 lbs.	Plot Copper Sulphate 0.3 lbs.	Plot 9. Check. Untreated.
Plot 10. Check. Untreated.	Plot 11. Calcium Chloride 5.2 lbs.	Plot 12. Ferrous Sulphate 5.2 lbs.	Plot 13 Check. Untreated.	Plot 14. Formalin. 48 lbs.	Plot 15. Sulphur. 10.4 lbs.	Plot 16. Check. Untreated.	Plot 17. Sodium Chloride 28.8 lbs.
Plot 18. Potassium(KCl). 10.4 lbs.	Plot 19. Check. Untreated.	Plot 20. Horse Manure. 700 lbs.	Plot 21. Copper Sulphate 1.035 lbs.	Plot 22. Check. Untreated.	Plot 23. Calcium Chloride. 3.0 lbs.	Plot 24. Ferrous Sulphate. 3.0 lbs.	Plot 25. Check. Untreated -
Plot 26. Formalin. 32 lbs.	Plot 27. Sulphur. 10.4 lbs.	Plot 28. Check. Untreated	Plot 29. Sodium Chloride. 28.8 lbs.	Plot 30. Potassium(KCl). 10.4 lbs.	Plot 31. Check. Untreated.	Plot 32. Copper Sulphate 0.5 lbs.	Plot 33. Horse Manure. 700 lbs
Plot 34. Check Untreated	Plot 35. Sodium Chloride. 28.8 lbs.	Plot 36. Potassium(KCl). 10.4 lbs.	Plot 37. Check. Untreated.	Plot 38. Horse Manure 700 lbs.	Plot 39. Fe_2SO_4, KCl, $CaCl_2$ 10.4 lbs.		
Plot 40. Calcium Chloride. 3.0 lbs.	Each plot contains the number of pounds applied to it.						

The plants of the three formalin-treated plots were free from Early Blight (*Cercospora apii*) until they were infected from adjoining plots. Thus it would seem that formalin served as a soil disinfectant against this organism.

Calcium Chloride ($CaCl_2$)—This salt does not neutralize acidity but is very toxic to most of the soil flora. It was applied March 31 in varying amounts as shown in Table III. Plot II, which received an application at the rate of 500 pounds per acre, gave an increase of 20 per cent in the first crop over the checks.

Copper Sulfate ($CuSO_4 5H_2O$)—This salt, applied at the rate of 30 pounds per acre on Plot 8, gave a 75 per cent control. As this chemical is very toxic to plant growth it is interesting to note that plants were not injured by an application of 100 pounds per acre.

Ferrous Sulfate ($FeSO_4 7H_2O$)—This salt is toxic to plant growth. It gave a slight control in one plot.

Composite Fertilizer, Potash and Horse Manure—These fertilizers increased the growth of the plants very much, but gave no control.

Sodium Chloride ($NaCl$)—As this is not a fertilizer, the purpose of its use was to set free the potash already in the soil. It showed favorably in one plot.

IV. Steam Sterilization

Object—The main objects of the experiment were as follows: (1) to discover if steam or steam plus formaldehyde would sterilize muck soil against the Crown Rot organism; (2) to arrive at some conclusions as to the practicability of using steam for soil sterilization on a field basis; (3) to determine how much pressure and for how long it should be maintained in order to render sterilization complete.

Field Operations—Operations were begun in the field on May 1, 1916, and continued for 6 subsequent days. A few days previous to commencing the soil had been thoroughly worked and made ready for planting.

Outfit

Engine—This part of the apparatus was a 6-horse power portable locomotive, Ajax boiler, which maintained a pressure from 60 to 85 pounds, with the gate valve slightly open.

Hose—The difficulty in moving a boiler over muck soil necessitated 80 feet of 1-inch rubber hose to connect it with the pan. This was very efficient and withstood all pressure to which it could be subject.

Pans—Kinds—Two pans, the one constructed of galvanized iron, and the other of spruce and hemlock, were used.

Galvanized Pans—These were built 10 feet long, 6 feet wide and 8 inches deep, of No. 22 gauge galvanized iron, bound around the bottom by a 2" x ⅛" sharpened band iron, and reinforced over the top and sides with four strips of 1¼" x ⅛" angle iron. Two of these ran crosswise of the pan and the other two lengthwise, attaching at their ends to the band of iron. The joints were folded double-seamed and soldered. The steam inlet was

in the center of the top and had a 1-inch flange junior and nipple bolted to the top. This was connected on the inside to a "T" into which screwed two 14" 1-inch iron pipes which carried the steam toward the two ends. This could be improved by using four 1¼-inch pipes instead of two, and having each one of them extended in the direction of one of the four corners, terminating two-thirds the distance between the inlet and the corners. The above suggested itself by an examination of the soil after raising the pan. Generally, the center soil was from 10° to 15° F. lower than that near the corner. All parts were riveted with malleable iron rivets 4 inches apart. For ease in handling two galvanized malleable iron handles were riveted to each end.

This method of adjoining, soldering, riveting and bracing made a rigid but lightly constructed pan of 250 pounds weight which withstood shipment and field usage in a very satisfactory manner. The cost of this pan complete was $35.00.

Wooden Pans—Due to the high cost of constructive material used in making a galvanized pan, it was thought that some sort of a box might be constructed that would serve in the same capacity. Thus, a box 10 feet long, 6 feet wide and 10 inches deep, was constructed as follows: two sides and two ends from three pieces of hemlock 12′ x 8′ x 2″; the top from 8 pieces of grooved spruce boards 13′ x 8″ x 1¼″; two top spruce braces running lengthwise of the pan 12′ x 2″ x 3″; 32 feet of 2¼″ x ¼″ continuous sharpened iron band around the bottom of the ends and the sides; 10 pounds of white lead, 3¼ dozen 11-25-inch screws and 5 pounds of nails used in joining. Steam was admitted in the same manner as described for the galvanized pan. It required four men to change it from plot to plot, but when once in the soil little trouble was experienced by the lifting power of the steam. It is to be preferred to the galvanized pan for field work. The box complete cost $17.78.

Temperature—A temperature of 210° to 215° F. was maintained for 1½ hours. This was taken by boring a hole through the top of the wooden pan near one end and inserting a thermometer.

Cost—Due to the inefficiency of the boiler used in this experiment there was approximately $125 for the sterilization of 1/45 of an acre. However, the results showed that steam sterilization will control the disease. If this were taken up by a community, and an efficient boiler purchased so as to keep four 100-square foot pans in continuous operation, it could be made practical, as the following figures will show. Allowing 45-minute periods, four pans would steam sterilize 5.333 square feet of soil per day, or in 8 days approximately 1 acre. Barring the initial cost of the outfit, which would be a small item in community work, the problem resolves itself to a question of labor and fuel. The labor of four men in this community could be had for $10 per day. For the 8 days this would amount to $80. Add to this the liberal allowance of $20 for fuel and the cost of various miscellaneous articles, would total $100, the approximate cost for the sterilization of one acre.

Plots—These plots were 20 feet long and 12 feet wide. All rows ran lengthwise.

Results—First Crop—The first crop consisted of four rows of Golden Self-Blanching celery. They were planted May 20 and harvested August 31.

From averages in the first crop the checks produced as many pounds as the treated plots. The failure to give better results with this crop was probably due to the physical condition of the soil.

The Second and Third Crops—The second crop consisted of one row; the third of two. The second crop was planted June 14; the third July 17. Both were harvested November 9. These crops showed a very decided gain in all plots for the steam sterilization, as may be seen from Table IV.

Table IV

Plots.	*Treatment.*	*—Weights in Pounds.—* *First Crop.*	*Second and Third Crops.*
1	Check-untreated, ...	15.00	20.00
2	Check-untreated, ...	10.00	18.00
3	Steam, ...	53.75	50.00
4	Steam + 20 lbs. formalin, ...	86.25	71.00
5	Check-untreated, ...	130.00	29.00
6	Steam + 20 lbs. formalin, ...	79.25	112.00
7	Steam, ...	95.00	81.00
8	Check-untreated, ...	90.00	8.50
9	Check-untreated, ...	96.00	7.00

V. Heart Rot of Celery

The Disease—The disease is caused by a bacterium. In the plant it produces a rotting which gives off a putrid characteristic smell. It attacks only the innermost tender heart petioles and leaves. From 6 to 13 of these have been observed to be infected in one plant. Generally, it starts at the tip of the leaves, and from this point of infection extends downward to the stem. However, cases have been observed where infection has taken place directly upon the stem. That the trouble is a serious one may be seen from an examination of the data taken from four celery plots. These plots grew approximately 92,000 mature plants, of which only 9,720 were free from this disease. The remaining 85,280, or 92 per cent of the crop, represent an entire loss. Reckoning these at 30 cents per dozen, this would incur a pecuniary loss of approximately $2,000.

Organism—The organism has been successfully isolated according to Koch's four rules. It is a bacillus non-acid former, making a rather slight growth upon most media. It is very active upon plants when they are artificially inoculated, causing the characteristic lesions to appear in less than 10 hours.

VI. Crown Rot Wilt

Disease—This disease has been found only upon plants almost matured. It is a matter of chance if a diseased plant is found in its early state, as there are no external symptoms of the disease above ground until it has progressed far into the plant.

Upon examining the roots of diseased plants it was found that the tap root and surrounding roots were invariably rotted or in an advanced state

of decay. These roots led directly to the diseased portion of the crown. To determine that the disease did enter the crown through the roots a number of diseased plants were chosen and the outside portion of the crown carefully cut off to see if there were any lesions leading to the inside cavity. None of these crowns showed any openings in their inside cavity. Thus it is only logical to conclude that the plants are infected only through the roots and rootlets. The organism once in the crown produces an ovoid cyst approximately 30 mm. in length and 15 mm. in diameter at its thickest portion. The medullary rays of the crown tissues are but slightly attacked and fall over on the sides of the cavity as folds. The rot is semi-wet in some cases, while wet in others, and in all instances producing a disagreeable odor. The first noticeable effects upon the foliage are a quick and severe wilting of the entire foliage as if the plants had been severely scalded. Plants that looked perfectly healthy at 6 A. M. are flaccid and prostrate on the ground by noon of the same day. This sudden and rapid wilting can be accounted for only in the following manner: The organism starts its work, as a rule, in the central region of the crown. It gradually works its way outward until it reaches the vascular bundles. Until this time the plants have a perfectly normal outward appearance. The bundles are then rapidly decomposed and the plant wilts as a result of its water supply being cut off. This year the disease caused but little loss. It is much feared by the growers because of the damage it has done in the past.

Organism—The writer has in culture an organism that appears to be the causal one, but refrains from further discussion until more experiments can be conducted.

VII. Early Blight (*Cercospora apii* Fr.)

Disease—Description—As the disease becomes apparent in the field, the infected area of the plant appears light yellow in color, soon becoming an ashen gray surrounded by a small light yellow area. While this change of color has been in progress the spot has become much sunken and the margin well defined. The mycelium now rapidly multiplies in the infected tissues, and occasionally parts of it are projected through the epidermis as fascicles of conidiophores upon which conidia are borne. As the spot reaches maturity it grows larger, turns a light brown color and is generally surrounded by a halo of yellow.

If moist weather conditions prevail, the mature spot becomes covered on both sides with a heavy mass of conidia and conidiophores. Spots frequently coalesce, consuming an entire leaf. The spots are amphigenous upon both stem and leaf. They may be circular, subcircular, triangular, angular, or half-moon in shape, according to their location upon the leaf. The stem may be infected directly by spores or by a continuation of the mycelial growth from the leaflets. The infected area becomes much water-soaked, sunken, and elongated in the direction of the longest axis of the petiole.

Seed-Bed Infection—With this point in view, and from the large number of seed-bed plants the writer has seen, he has never succeeded in finding a single Cercospora spot on any seedling under 6 weeks of age. From labor-

atory work it has been found that spores die after being exposed to desiccation from 2 to 3 months. This, accompanied with the fact that seed is rarely sown by most growers under 2 years, would point to the fact that there is little or no danger of spreading the disease by seed.

First Appearance of the Disease—In this region the disease first made its appearance simultaneously over most of the farms between June 6 and 10.

Weather—Moist, warm, weather affords the most ideal conditions for the rapid development and dissemination of this organism. From June 6 until August 30, the amount of infection gradually became worse. During the latter half of this period high temperature and heavy fogs prevailed with an increasing seriousness of the disease. From August 30 the disease was gradually on the wane until November 1, when scarcely a Cercospora spot could be found over the entire acreage.

Means of Dissemination—Manures, winds, animals, insects, tools, rain and cultivations are the main factors in the spreading of this organism.

Losses—In this region the loss on the unsprayed plots varied from one-third to total for the first and second crops.

Organism—The organism belongs to the "Fungi Imperfecti" and is classified as a Moniliales-dematiaceæ-scolecosporæ.

In the leaf and the petiole of the leaf the mycelium is intercellular, filling the intercellular spaces and the region of the middle lamellæ with sclerotial bodies.

In culture the organism produces an abundant olivaceous floccose growth of mycelium which bears conidia very sparingly.

VIII. Late or Black Blight

(*Septoria petroselini* Desm. var. *apii* Br. & Cav.)

On Leaf—This blight is first brought to our attention by a small area of the leaf turning yellow, followed by a rapid sinking of the entire yellow area and changing of its color to brown. At this period the spot has a definite, regular border, and soon begins to produce scattered pycnidia in no definite location. The pycnidia are small, papillate, pinhead bodies which produce the conidia. They may occur upon either surface of the leaf, but in the Oradell-Ridgewood region they are ten times as numerous upon the upper surface of the leaf as on the lower. The infected area continues spreading until it has reached maturity. In this State it appears with a light-brown central area surrounded by concentrically arranged dark-brown cotigenous region between it and the border. Immediately on the outside of the border is another area of light yellow color.

If the spots are numerous, coalescing often results, in which most of the leaf is finally reduced to a dry, shriveled mass.

On Stem—On the stem the organism produces an elongated, water-soaked area which soon becomes dotted with pycnidia. Infection may come from leaflet infection or from direct spore infection. In the stem the mycelium is intercellular and frequently forms sclerotial-like bodies.

Seed-Bed Plants—From a large number of examined seed-beds none were found that had the late blight.

First Appearance in the Field—The disease first appeared in the Oradell-Ridgewood region July 15, and on the plots at the New Jersey Agricultural Experiment Station farm July 18.

Spreading—This disease is disseminated by the same agents as mentioned under Cercospora.

Losses Caused by Late Blight—The losses caused by the late blight organism upon different farms in this region varied from the entire absence of the disease to a nine-tenth loss.

The Organism—The organism belongs to the "Fungi Imperfecti" and is classified as Sphæropsidales-scolecosporæ. The spores are needle-shaped, generally 2-4 septate and occur in small papillate-pycnidial bodies. In culture it produces a very carbonaceous growth in the media while the surface is covered with a grayish-white aerial growth.

IX. Over-wintering of Cercospora apii Fr. and Septoria Petroselini Desm. var. apii Br. & Cav.

Laboratory studies during the past two years of pure culture of these organisms in different media, and under different environmental influences, such as light, temperature, moisture, etc., without discovering the perfect stage of either, have led the writer to conclude that they are not produced readily or at all in artificial media.

Further evidence has its bearing along this line in that diseased leaves have been kept out-of-doors in wire baskets throughout the year and examinations made from time to time to see if the perfect stage had developed. Likewise, this failed to show the perfect stage. Also laboratory work shows that the Cercospora spores die after 3 months of desiccation. Likewise, it was found that Septoria spores die after 8 months of desiccation.

The above work has led the writer to believe that the organisms must winter as live sclerotial bodies in the leaf and petiole tissues. On September 21 of this year, with this point in view, three lots of fresh celery leaves, badly infected with Cercospora, were placed in the field at three different levels relative to the earth's surface, viz., on the surface, and 7 and 10 inches, respectively, below. The Septoria organism was treated in the same way, except that it was buried at another place on October 15.

A 2¼ x 2¼-inch top and bottom galvanized wire netting of a ⅜-inch mesh was used as a protection to the buried material. Examinations have been and will be made throughout the coming year to determine the longevity of the spores and the sclerotial masses of mycelium. No results can be given at this time (November 20, 1916).

X. The Spell Spray Experiments

No. 1—This project was started July 21 in the worst diseased area of the region. Both the early and late blight were present.

The primary object was to see if a Bordeaux 5-6-50 would control these blights after they had gained a foothold.

The plots consisted of 6 1/40-acre areas of Golden Self-Blanching celery. Three plots each of the second and third crops were sprayed and three were left unsprayed. The dates of the first and last spraying were as follows: Second crop, July 21 and September 20; third crop, August 21 and October 27. The second crop was sprayed on 5 different dates. The third crop on 6 different occasions.

The following is an explanation to Table V, which relates to Spell's experiment:

Bordeaux, 5-6-60, ...Nos. 1, 3 and 5.
Checks, ...Nos. 2, 4 and 6.
F=First crop in lbs. S=Second crop in lbs.

Table V

Results of Spell Spray Experiments

Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6	
F	S	F	S	F	S	F	S	F	S	F	S
795	801	432	456	846	775	387	302	783	678.6	355	360.6

Discussion—The data from Table V show that the second crop which was sprayed to prevent *early blight* averaged 808 pounds for the sprayed plot and 391.3+ pounds for the unsprayed. This increase is 25.4 pounds in excess of a double yield for the sprayed over the unsprayed.

Also the data from Table V show that the third crop which was sprayed to prevent late blight averaged 751.5+ pounds for the sprayed plots and 372.8+ pounds for the unsprayed. This increase is 5.9 pounds in excess of a double yield for the sprayed plots over the unsprayed.

The early blight caused 99 per cent. of the damage in the second crop. The late blight, as previously stated, was present, but due to the warm weather conditions at that time of the year spread but slightly. The sprayed plots, when harvested October 3, showed only scattered spots of the early blight, whereas the checks were badly rotted by the Cercospora organism.

The third crop was harvested November 13. Practically all the damage done to this crop was due to the Septoria organism, as the Cercospora began to vanish by the first of September. The Septoria proved to be much more difficult to control, and required more intense applications of the spray than the Cercospora. That both organisms can be checked in their progress with a Bordeaux 5-6-50 is conclusive from this experiment.

No. 2—This project consisted of two rows of Golden Self-Blanching celery, 240 feet in length, sprayed 3 times with 10-50 Kil-Tone, alternating with two unsprayed check rows. The first spray was applied August 1 and the last August 23 The two Kil-tone-treated rows produced 1,088.5

pounds of celery, whereas the two checks produced 747.0 pounds. This shows a total of 341.5 pounds on the two rows in favor of the Kil-Tone spray over the unsprayed plots.

No. 3—Two rows similarly arranged and of the same length as in No. 2 were twice dusted with sulfur dust on August 1 and 8. The checks and dusted plots showed no differences.

No. 4—This project was begun September 20 on six 1/40-acre areas of third crop Golden Self-Blanching celery. The primary object was to determine if a 4-5-50 Bordeaux mixture would give as good results as a 5-6-50 Bordeaux mixture or a 10-50 Kil-Tone. Three sprays were applied, the first September 20, the last October 17.

Explanations of the Table Relating to Project No. 4:

Bordeaux, 4-5-50, ...Plots 1, 3 and 5.
Checks, ...Plots 2, 4 and 6.
All weights are expressed in pounds.

Table VI

Result of Bordeaux Spray

Plot 1 Third Crop	Plot 2 Third Crop	Plot 3 Third Crop	Plot 4 Third Crop	Plot 5 Third Crop	Plot 6 Third Crop
424	265	363.5	310	337	286

Discussion—The average for each Bordeaux plot was 304.8 pounds; that of the checks 287 pounds. This gave a difference of 87.8 pounds in favor of the Bordeaux-sprayed plots. Although these plots were adjoining No. 1, the blight was less severe in the checks. Another reason for the difference between these plots in No. 1 and this one is that there were 4 rows to each plot in project No. 1, whereas there were only 3 to the plot in this project. However, making allowance for this, the Bordeaux 5-6-50 still gave a larger increase.

XI. Tunis Drenth's Spray Projects

This spray project was begun July 19, twelve 1/96-acre plots being used. The first crop consisted of Golden Self-Blanching celery and the second of the New Easy Bleacher. The only blight present was the Cercospora.

The spray materials used were Bordeaux 5-6-50 and Kil-Tone 10-50. Owing to the excessive rain at the time the experiment was started, 6 different applications were necessary. Due to a misunderstanding, the celery in the plots was removed before weighings could be made. However, the writer saw them a few days before removal and can safely state that the sprayed plots were fully twice as good as the unsprayed.

Bordeaux Stimulation—These plots were set about July 3, and were sprayed on July 19 and 27, and August 7. Although among plants of the second crop that were blighted with the Cercospora, neither the checks nor the sprayed plots were infected. Thus on August 7 it was decided to discontinue the spraying upon this third crop. From August 10 until the crop was harvested, November 10, the plants in the sprayed plots grew better and produced heavier stools, as is shown by Table VI. The writer realizes that Bordeaux stimulation is a disputed question; nevertheless, the fact remains that with the same number of plants to each of the plots, with a uniform muck soil, and no disease present, there was a decided falling off in pounds in each of the four check plots. This, together with similar results obtained upon seedlings in the greenhouse, would point to the natural conclusion that a copper spray does have a stimulating effect upon celery plants.

Table explanations:

Bordeaux 5-6-50, ...Plots 1, 4, 7 and 10.
Kil-Tone 10-50, ...Plots 2, 5, 8 and 11.
Checks, ...Plots 3, 6, 9 and 12.
All weights are expressed in pounds.

Table VII

Results of Spraying with Kil-Tone and Bordeaux

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12
434.5	419.5	380.	428.5	417.	380.5	448.	447.5	384.5	432.5	423.5	394.

XII. Kniper Spray Projects

This experiment was started July 28. The object of the experiment was two-fold, viz., (a) to discover if a Kil-Tone 10-50 and a Bordeaux 5-6-50 would control the disease, and (b) to see which of these two sprays would prove to be the more efficient. The results are given in Table VIII.

The experiment consisted of eight 1/40-acre plots. Each of the sprays was used on 3 different plots. Three crops of Golden Self-Blanching celery were grown. The loss in the first crop was due mainly to the Cercospora organism, whereas in the second crop the injury was about equally distributed between it and the Septoria organism. The third crop loss was almost entirely due to the Septoria organism.

Table explanations:

Bordeaux 5-6-50, ...Nos. 2, 5 and 8.
Kil-Tone 10-50, ...Nos. 1, 4 and 7.
Checks, ...Nos. 3 and 6.
F=First crop. S=Second crop. T=Third crop.

Table VIII

Results of Kniper Spraying Experiment

Plot 1			Plot 2			Plot 3			Plot 4		
F	S	T	F	S	T	F	S	T	F	S	T
253	303.5	242	240	270.5	222	183.5	174.5	163	199	231	268.5
Plot 5			**Plot 6**			**Plot 7**			**Plot 8**		
F	S	T	F	S	T	F	S	T	F	S	T
196.5	264	240	149	124	107	208	219	267.5	224.5	247	232

The first crop was sprayed 3 times, the second 4, and the third 6 times. In all cases the Cercospora and Septoria blights were present when the experiment was started.

Discussion—The averages for each plot of the following crop were: Bordeaux 220.5 pounds, Kil-Tone 220 pounds, checks 166.25 pounds. For this crop the two sprays gave an average increase of approximately 33 per cent over the checks.

The average for each plot of the second crop were: Bordeaux 260.5 pounds, Kil-Tone 251.1 pounds, checks 149.25 pounds. This gave an approximate increase of 40 per cent over the checks in favor of the two spray materials. The averages for each plot of the third crop were: Bordeaux 259.6+ pounds, Kil-Tone 231.3+ pounds, checks 135 pounds.

XIII. Drenth Bros. Spray Project

This experiment was started August 1. Twenty-seven 1/40-acre plots were laid out and sprayed twice, except Plots 1, 2, 3 and 4, which were sprayed three times.

The primary object of this experiment for the control of late blight was to test sulfur-dust, Bordeaux 5-6-50, Bordeaux 3-4-50, sulfocide, ammonical copper carbonate, Kil-Tone 10-50 and Kil-Tone 5-50 in a series of 3 plots each, distributed over approximately three-fourths of an acre.

The growers do not distinguish between the Cercospora and Septoria blights, and the writer, not being familiar with conditions in previous years, was misled, although not intentionally. Most of this area was badly infected with early blight and since the spraying was started late, this disease was only partially checked in the second crop.

Results will be given from only 6 of the plots. The difference noted is due to the protection against early blight as the late blight never appeared.

Explanation to Table IX: In field arrangement Plots 5, 6, 7 and 8 lay parallel to Plots 1, 2, 3 and 4. Plot 1—Sulfur Dust, Plot 2—Bordeaux 5-6-50,

Plot 3—Check, unsprayed, Plot 4—Kil-Tone 10-50, Plot 5—Bordeaux 3-4-50, Plot 6—Check, Plot 7—Ammonical copper carbonate, Plot 8—Sulfocide.

Table IX

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8
256 lbs.	254	157	141.5	262	142.5	170	118

Discussion—The land in Plots 1 and 5 was better than in the other plots. Plot 5 had 38 less plants than Plot 1, yet it produced 6 pounds more celery. Plots 2 and 6, which lay parallel, had similar soil and the same number of plants. However, Plot 2 produced 111.5 pounds more than Plot 6. Plots 3, 4, 7 and 8 were infected with crown-rot trouble. Due to the large number of dead plants, nothing definite can be said of the spray treatment for the last mentioned plots.

XIV. The James Neilson Project

This experiment was started July 31. Six different applications of spray were made between the above date and September 26, when the spraying was stopped, as no blights appeared.

Bordeaux 5-6-50 and Kil-Tone 10-50 were used as sprays. The celery is still in the ground as this goes to press, so no weights could be included. The crop was attacked by the flea beetle. The spray served as a repellant to this insect, and as a result a difference can be seen between sprayed and unsprayed plots.

XV. The Project on the New Jersey Agricultural Experiment Station Farm

The object of this experiment was to see if one spray would control the early blight organism. A Bordeaux 5-6-50 spray was applied after the organism had started upon the plants. Several hard rains followed, and as a result scarcely any difference could be seen between sprayed and unsprayed plots.

XVI. Hillman Spray Project

On the farm of Charles Hillman, near Paterson, New Jersey, the Station, in coöperation with Mr. L. F. Merrill, the Bergen County farm demonstrator, conducted an experiment for the control of the late blight on celery under the environmental influences of that locality. About three-fourths of an acre growing the New Easy Bleacher celery, which was already slightly infected with the early and late blights, was sprayed with a 5-6-50 Bordeaux mixture August 28. One-half of the same tract was again sprayed with a spray of a similar strength September 20. After September 20 spraying was discontinued, as the blight made little progress on sprayed or unsprayed plots.

On November 2 the field was last examined. The sprayed plots showed a slight increase in growth over the unsprayed, although not enough to more than pay for the cost of spraying. A slight amount of late blight was present on all plots at this time.

Although the experiment failed to bring large financial returns, nevertheless it brought out some important factors.

1. In 1915 the grower lost from one-half to three-fourths of his crop of Golden Self-Blanching celery through the attack of the Septoria fungus. He sprayed once with Bordeaux after the celery was badly blighted, but got no results.

2. Due to this failure in 1915, the grower planted in 1916 a strain of the New Easy Bleacher, which, in this locality, seems to be fairly resistant to fungus attacks, whereas in the Oradell-Ridgewood region it is frequently affected almost as badly as the Golden Self-Blanching variety.

3. The one spray of 1915 and the time of application as previously referred to shows plainly that a systematized method of spraying is very essential in the control of this organism.

4. Why are these epidemics of late blight so spasmodic? It might be argued that certain varieties and strains of varieties are more resistant than others; that one year the seed is more contaminated than in other years; that the climate is more unfavorable some years than others; and that the soil is more unfavorable for the over-wintering and growth of the organism than others.

From laboratory work and field observations for the past 2½ years the writer is more inclined to believe the truth of the real cause, for these sudden epidemics lies in the last two theories of the preceding paragraph.

5. In 1912 the late blight was first noticed on this farm. It gradually became worse from year to year until the epidemic of 1915. Until this year (1915) the seed-bed had been on ground that had never been planted to celery. In 1915 the seed-bed was chosen where considerable blight had been the year before. This year the seedlings were badly blighted, although the seed used in 1914 and 1915 was from the same source. Therefore, if the organism is disseminated by the seed, the blight should have been as severe in 1914 as in 1915. The fact that there was an epidemic in 1915 would indicate that the soil is a medium in which the organism readily passes the winter. The fact that the blight gradually increased in its severity from 1912 to the epidemic of 1915 further substantiates the theory that the organism may over-winter in the soil.

Spray Gains

In computing gains the spray work done on Spell's project No. 1 will be used as a basis, as it was in the midst of one of the worst infected areas.

The question at once arose, "Does twice the number of pounds mean a doubled financial income?" After consulting the leading growers upon this subject and having their statements that it meant a doubling or more in the way of a financial income, the writer feels at liberty to make his computations upon this basis.

Each of the sprayed 1/40-acre plots No. 1 yielded on the average of 46 dozen plants. This year prices have varied between 30 and 50 cents per dozen plants. Reckoning at 40 cents per dozen, the value of 46 dozen would be $18.40, the gross income from one sprayed plot. One-half of the amount, or $9.20, represents what each of the unsprayed plots produced in gross returns. $18.40—9.20=$9.20 gain on each 1/40-acre plot that was sprayed.

Then $368 would represent the gain on one acre of celery minus the cost of spraying. On an average, the spray was used at the rate of 100 gallons per acre for each of the 5 sprays. Then 1/40-acre plot required 12.5 gallons of spray for the season on one crop.

The lime cost 2 cents per pound. The copper sulfate cost 16 cents per pound. A 5-6-50 Bordeaux mixture was used. Then 12.5 gallons of spray would require 1.25 pounds of lime and 1.5 pounds of copper sulfate. Therefore, 26.5 cents is the total cost of material for spraying one plot the entire season. The cost of material for each acre would amount to $10.00. The "Pomona" barrel sprayer was used. It took 2 men 20 minutes to mix and spray one plot. The labor of two men in applying the 5 sprays to one plot would cost 83⅓ cents. Then, the total cost for spraying one plot would amount to $1.09. By the use of a power sprayer the total cost of spraying could be reduced to two-thirds of the amount herein given. $9.20—1.09= $8.11, the gain on a 1/40-acre plot due to spraying. One acre of sprayed celery would yield, at this rate, $324.00 per acre profit over the unsprayed.

Summary

Complete control of hothouse soil organisms pathogenic for celery was obtained in the following manner: The old soil was removed, the house thoroughly swept, and sprayed with a 5-6-50 Bordeaux mixture, after which clean soil was placed in the benches and treated with formaldehyde 3.25-50. Also, old soil was treated with the above-mentioned formalin solution and gave good results.

From the above treatment the largest percentage of good plants were taken from those plots sown 7 days after the application of the formalin.

Dried blood, sodium nitrate and potash gave good results as fertilizers in the hothouse.

A 3-4-50 Bordeaux caused an increased growth of the seedlings in the hothouse.

Steam sterilization gave approximately a seven-eights control for the crown rot organisms.

Formalin, copper sulfate, calcium chloride, and ferrous sulfate were the only chemicals that showed any *germicidal* effect for crown rot.

Celery seedlings will not grow in soil treated with formaldehyde until 13 days after the application.

The Cercospora and Septoria blights were best controlled by a Bordeaux 5-6-50 mixture and a Kil-Tone 10-50 mixture.

The Cercospora occurs early in the year and reaches its maximum degree of dissemination only during moist, hot weather, whereas the Septoria grows best during cool, moist weather.

XIII

REPORT OF POTATO SPRAYING EXPERIMENTS

H. CLAY LINT

Coöperative potato spraying experiments were conducted by the Department of Plant Pathology during 1916. These were very similar in plan and scope to the ones which have been carried on for the past three years.

New Jersey conditions possess peculiar factors bearing upon this problem, and the results obtained during the past year must be correlated with previous work in order to arrive at the best interpretation. Briefly, the situation may be outlined upon the broad basis of the purpose for which potato spraying is done:

(1) *Control of fungous diseases.* New Jersey potatoes are affected with practically every fungous disease of importance, but those which can be controlled by spraying assume only minor importance. The "early blight" (*Alternaria solani*) and the "late blight" (*Phytophthora infestans*) are the two important diseases encountered in the northern potato sections. These can be effectively controlled by spraying, but in New Jersey the late blight is only rarely in evidence except in the more northern counties. Even there it fails to assume the proportions of an epidemic. The early blight ordinarily appears in late July at a time when the potato vines are starting to die normally, so that its presence probably does not decrease the yields materially. The necessity of spraying for the control of fungous diseases does not impress itself, therefore, very forcefully.

(2) *Control of insect enemies.* Undoubtedly, the two principal insect pests of the potato, the Colorado potato beetle (*Leptinotarsa declimlineata*) and the potato flea beetle (*Epitrix cucumeris*), work considerable injury to foliage. Everyone will concede that it is necessary to apply arsenicals of one description or another to control the former. Actual poisoning of the flea beetle is a more difficult task, and to date it can be stated that homemade Bordeaux mixture, to which lead arsenate has been added, is the most effective means of minimizing the ravages of this pest. A better control of the flea beetle, therefore, constitutes the first logical argument for the application of spray materials to potato foliage in New Jersey.

Control of tip-burn and plant stimulation. Recent work has tended to confirm the opinion of many growers and experimenters that one of the chief benefits of Bordeaux spraying arises because of a decreased injury due to tip-burn. Tip-burn is quite prevalent in this State so that a second reason for spraying is apparent.

While the stimulating effect attributed to copper compounds is imperfectly understood, it has been observed repeatedly in our spraying work that the vines on plots so treated remained green for 5 to 14 days longer than vines not sprayed with copper compounds. Even where the diseases were not a factor this has been observed, and it would appear logical to expect increased yields on this account.

Some of our previous experiments summarized in the Annual Reports of the Experiment Station, for 1913, 1914 and 1915, here show marked effects from Bordeaux spraying. Roughly speaking, the increase averages about

30 bushels per acre. The lack of consistent duplications in different parts of the State and the variations due to seasonal factors have tended to discount the favorable reports. From the economic standpoint the value of the increased yield has not always warranted the added expense. Undoubtedly, this farm management phase of the problem must be considered before broad recommendations in potato spraying can be made.

Five experiments were made on first-crop potatoes and one on the second crop during 1916. These were conducted on the farms of Messrs. J. Harry Kandle, at Elmer; John Black, Mount Holly; Edward Winsor, Farmingdale; and H. Courtney Brown, Jamesburg. The fifth was located at the College Farm on a part of the experimental tract of the department. These several experiments will be taken up separately.

Through the hearty coöperation of several commercial concerns, the scope of these experiments has been considerably broadened.

Through Mr. F. H. Pough, its research manager, the Union Sulphur Company of New York has provided the sulfur-lead arsenate dusts, lead arsenate and the machines necessary for applying the dust mixtures.

The Kil-Tone Chemical Company of Newark, New Jersey, has coöperated through their chief chemist, Mr. C. D. Vreeland. This company was especially generous, supplying a large enough quantity for use on the numerous check plots in two of the experiments.

The Sherwin-Williams Company, manufacturers of "Tuber-Tonic," and the Thompson Chemical Company, manufacturers of the "Pyrox," have coöperated through their managers, Mr. C. P. Jarden and Mr. O. B. Briggs, respectively.

"Iron-Age" traction sprayers were generously supplied by Mr. Frank Bateman, of the Bateman Manufacturing Company, of Grenloch, New Jersey.

The courtesy of the growers with whom we have coöperated merits attention. Added labor and expense have been incurred as well as interferences with other work in order to make application at the convenience of the department representative.

Spraying Experiment in Coöperation with Mr. J. Harry Kandle, Elmer, N. J.

This experiment was conducted on the field used in 1915. The area was divided into 37 plots, each 8 rows wide. Irish Cobbler potatoes were planted, but due to the fact that seed from two different sources were used it was necessary to plant 4 rows of each plot with the one type and the remaining four rows with the other in order that the seed would not be a factor.

One ton of 4-8-5 fertilizer was applied at the time of planting during the week of April 12 to 19. Four applications of spray were made on May 27, June 6, June 17, June 29. The following materials were used:

Kil-Tone—10 lbs. paste to 50 gal. water.
Bordeaux mixture—5-5-50 + 3 lbs. of lead arsenate.
Lead arsenate—3 lbs. dry powder to 50 gal. water.
Pyrox—10 lbs. paste to 50 gal. water.
Tuber-Tonic—3 lbs. dry powder to 50 gal. water.
Lime-sulfur—1 gal. to 49 gal. water + 3 lbs. dry lead arsenate.
Sulfur-lead arsenate—5 parts of sulfur to 1 of lead arsenate.

All wet sprays were applied at the rate of 100 gallons per acre. Thirty pounds per acre of the sulfur-lead arsenate were used. It is to be noted that probably larger quantities of materials were used than were necessary, but it was desired to put all materials on a uniform basis and to obtain maximum results if possible. Having established these, it will then be necessary, of course, to work out the minimum quantity required to obtain this maximum result. In the case of Tuber tonic too large a quantity was

Table X

Yields from Plots in the Spraying Experiment Conducted in Coöperation with J. Harry Kandle, Elmer, N. J., 1916

Plot No.	Treatment	Yields in Bushels Per Acre					
		Kandle Seed			Minch Seed		
		Firsts	Seconds	Total	Firsts	Seconds	Total
1	Kil-Tone,	328.49	46.45	374.94	345.08	46.45	391.53
2	Bordeaux,	328.99	36.64	365.63	338.95	36.64	375.59
3	Lead Arsenate,	317.70	33.19	350.89	282.78	46.57	329.35
4	Kil-Tone,	333.10	43.30	376.40	339.76	43.30	383.06
5	Sulfur-Lead,	320.20	35.85	356.05	333.54	35.85	384.39
6	Tuber-Tonic,	287.22	41.75	328.97	314.42	44.98	359.40
7	Kil-Tone,	359.0	38.95	397.95	369.0	42.40	411.40
8	Pyrox,	389.0	33.55	372.55	321.0	34.15	355.15
9	Lime-Sulfur,	341.5	39.1	380.6	.....	.....	.....
10	Kil-Tone,	375.0	35.15	410.15	.....	.....	.....
11	Bordeaux,	343.0	44.7	388.7	.....	.....	.....
12	Sulfur-Lead,	366.5	36.25	402.75	.....	.....	.....
13	Kil-Tone,	355.5	40.6	396.1	.....	.....	.....
14	Lead Arsenate,	335.5	42.9	378.4	342.8	48.55	391.35
15	Pyrox,	346.7	32.2	378.9	348.0	32.2	380.2
16	Kil-Tone,	349.2	34.6	383.8	326.8	34.6	361.4
17	Tuber-Tonic,	288.5	42.9	331.4	319.5	39.0	358.5
18	Lime-Sulfur,	293.2	39.65	332.85	322.8	47.6	370.4
19	Kil-Tone,	347.0	40.8	387.8	314.5	56.6	371.1
20	Bordeaux,	343.0	45.0	388.0	349.5	40.9	390.4
21	Tuber Tonic,	280.5	47.7	328.2	307.2	43.65	350.85
22	Kil-Tone,	350.5	52.75	403.25	346.0	54.9	400.9
23	Lead Arsenate,	300.25	47.15	347.45	377.5	43.85	421.35
24	Lime Sulfur,	279.0	53.6	332.6	344.7	53.6	398.3
25	Kil-Tone,	288.5	53.3	341.8	359.5	53.3	412.8
26	Sulfur-Lead,	326.0	49.8	375.8	312.0	58.9	370.9
27	Pyrox,	341.2	55.3	396.5	332.0	55.3	387.3
28	Kil-Tone,	331.3	47.0	378.3	296.0	51.8	347.8
29	Bordeaux,	354.0	38.28	392.28	320.5	47.85	368.35
30	Pyrox,	296.8	48.6	345.4	311.2	48.6	359.8
31	Kil-Tone,	352.8	54.7	407.5	367.5	47.5	414.7
32	Tuber-Tonic,	296.0	36.45	332.45	314.0	32.9	346.9
33	Lead-Arsenate,	366.6	32.3	398.9	361.3	34.86	396.16
34	Kil-Tone,	345.0	36.9	381.9	.....	.....	.....
35	Sulfur-Lead,	334.0	25.5	359.5	.....	.....	.....
36	Lime-Sulfur,	324.3	27.47	351.77	.....	.....	.....
37	Kil-Tone,	350.5	22.6	373.1	.....	.....	.....

applied for the first two sprays. Some injury to the vines resulted, and for that reason it would be unfair to this material to accept the yields as a correct index of its value when properly used.

The two types of seed used are referred to as "Kandle Seed" and "Minch Seed," respectively. Both Mr. Kandle and Mr. Minch are leaders in the

production of second-crop seed in South Jersey. The Kandle tubers were medium to large in size, had been planted early in 1915, and had arrived at a normal maturity before frost. The Minch seed were quite small, grown from stock planted late in 1915, and had not fully matured before frost. In view of the fact that Mr. Minch advocates the use of these small tubers, this comparison of his seed with the best of what might be called "normal" second-crop seed was considered worthy of attention. In all, there were 28 plots in which these two types of seed were planted. The mathematical average for the Kandle seed was 367.32 bushels per acre and for the Minch seed 378.21 bushels per acre. While this difference is not large, it opens up a very interesting problem in second-crop production.

The yields from the various plots of this experiment are given in Table X.

In calculating the influence of any spray material, the "calculated yield" for any particular plot has been computed on the basis of the yields of the check plots on either side. The difference between this calculated yield and the actual yield has been taken as the difference due to the spray material. In this experiment Kil-Tone was used as a check, and the following table shows the relative efficiency of the different spray materials as compared with Kil-Tone:

Spray	*Average Difference*
Kil-Tone,	Check
Bordeaux,	— 4.74
Lead arsenate,	—17.97
Sulfur-lead arsenate,	—18.98
Tuber-tonic,	.....
Pyrox,	—21.31
Lime-sulfur,	—23.44

(Average yield 13 Kil-Tone plots—386 bushels per acre.)

Experiment in Coöperation with Mr. John Black, Mount Holly, N. J.

This experiment was conducted on 27 plots each 8 rows wide. The blocks were located in the middle of an irregular-shaped field, about 35 acres in size. The actual area under test was about 20 acres. The field has been intact for a number of years, and should be very uniform in fertility. The soil is a rather light phase of loam, in a high state of cultivation and admirably adapted to potatoes.

The field was planted with Irish Cobbler potatoes, northern-grown seed. A very uniform stand was obtained and the entire field was listed as one of the best in the vicinity of Mount Holly during the season.

In general, this experiment duplicated the one conducted at Elmer. Bordeaux mixture was used on the check plots rather than the Kil-Tone, as at Elmer, and Tuber-tonic was used as a dry dust in mixture with the Limeoid to demonstrate the advantages of a fungicidal spray over the Paris green treatment most common in this section. We set apart three plots to be dusted at the direction of Mr. Black. This might more nearly represent the actual farming practice than if the Department had assumed this direction. In this connection it should be noted that only two applications of Paris green were necessary to control the Colorado potato beetle effectively.

All other plots were sprayed four times during the season—June 1, June 12, June 19 and June 28, respectively.

Through the coöperation of Mr. F. E. Embree, of the Burlington County Farmers' Exchange, we were able to test out Mechling's Hydroxcide, a proprietary Bordeaux. This material was used at the rate of 10 pounds to 50 gallons of water.

Table XI

Results of Potato-Spraying Experiment Conducted in Coöperation with John Black, Mount Holly, N. J., 1916

Plot No.	SPRAY	Yields in Bushels Per Acre		
		Actual Yield	Calculated Yield	Spray Difference Due
1	Bordeaux (Check),	197.74	.....	.....
2	Hydroxcide,	222.64	212.59	+ 10.05
3	Kil-Tone,	180.90	227.43	— 46.49
4	Bordeaux (Check),	252.29	.....	.....
5	Lead Arsenate,	229.28	252.31	— 23.03
6	Sulfur-Lead Arsenate,	184.79	252.32	— 67.53
7	Bordeaux (Check),	252.34	.....	.....
8	Paris Green,	210.29	238.29	— 29.00
9	Tuber Tonic,	246.78	264.24	— 17.51
10	Bordeaux (Check),	270.20	.....	.....
11	Kil-Tone,	197.21	261.56	— 64.35
12	Lead Arsenate,	280.34	252.94	+ 27.40
13	Bordeaux (Check),	244.34	.....	.....
14	Sulfur-Lead Arsenate,	242.94	248.07	— 5.13
15	Paris Green,	201.07	251.80	— 50.73
16	Bordeaux (Check),	255.55	.....	.....
17	Hydroxcide,	236.54	244.15	— 7.61
18	Sulfur-Lead Arsenate,	214.14	232.75	— 18.61
19	Bordeaux (Check),	221.35	.....	.....
20	Tuber Tonic,	190.26	217.85	— 27.00
21	Kil-Tone,	198.39	214.35	— 15.96
22	Bordeaux (Check),	210.85	.....	.....
23	Lead Arsenate,	182.81	211.19	— 26.38
24	Tuber Tonic,	173.17	211.53	— 38.36
25	Bordeaux (Check),	211.87	.....	.....
26	Sulfur-Lead Arsenate,	191.04	211.87	— 20.83
27	Paris Green,	160.67	211.87	— 61.20

The crop was dug about August 14 to 21. The tubers were of excellent quality and the grading was rather close. Consideration should, therefore, be made of this in regarding the yields of first size tubers.

The relative efficiencies of the various spray materials are shown to better advantage in the following table:

Spray Material	*Average difference in bushels per acre*		
	Firsts	*Seconds*	*Total*
Bordeaux (Check) [1]			
Hydroxcide,	+ 1.26	— .04	+ 1.22
Kil-Tone,	— 36.60	— 5.66	— 42.26
Lead arsenate,	— 11.44	+ 4.11	— 7.33
Sulfur-lead arsenate,	— 32.44	— 4.92	— 37.36
Tuber-Tonic.[2]			
Paris green,	— 47.88	— 5.76	— 53.64

[1] Average yield of Bordeaux check plot 225.17 bushels per acre.

[2] Omitted since material was not applied as a wet spray.

Spraying Experiment Conducted in Coöperation with Mr. Edward Winsor, Farmingdale, N. J.

Spraying work in Monmouth County has heretofore been done on potatoes of the American Giant variety. No differences of practical importance were obtained due to spraying treatments in the experiments conducted at Freehold in coöperation with Mr. Frank Jones. It was noted that the exceptional fertility of this field might have been a factor in producing these negative results.

Table XII

Results of Spraying Experiment Conducted in Coöperation with Edward Winsor, Farmingdale, N. J., 1916

Plot No.	VARIETY	SPRAY	Yields in Bushels Per Acre		
			Calculated Yield	Actual Yield	Difference
1	Cobbler, ...	Kil-Tone, ...	.....	259.1	.....
2	"	Bordeaux-Lead Arsenate,	241.67	251.33	+ 9.66
3	"	Lead Arsenate, ...	224.25	250.33	+ 26.08
4	"	Kil-Tone, ...	.....	206.83	.....
5	"	Sulfur-Lead Arsenate, ...	215.49	252.0	+ 36.51
6	"	Bordeaux-Lead Arsenate,	224.15	301.0	+ 76.85
7	"	Kil-Tone, ...	.....	232.83	.....
8	"	Lead Arsenate, ...	226.30	267.16	+ 40.86
9	"	Sulfur-Lead Arsenate, ...	219.73	207.75	— 11.98
10	"	Kil-Tone, ...	.....	213.16	.....
11	Aroostook Prize,	Kil-Tone, ...	.....	301.55	.....
12	" "	Bordeaux-Lead Arsenate,	316.92	381.66	+ 64.74
13	" "	Lead Arsenate, ...	331.29	397.66	+ 66.37
14	" "	Kil-Tone, ...	.....	347.66	.....
15	" "	Sulfur-Lead Arsenate, ...	351.33	338.33	— 13.0
16	" "	Bordeaux-Lead Arsenate,	354.99	345.00	— 9.99
17	" "	Kil-Tone, ...	.....	358.66	.....
18	" "	Lead Arsenate, ...	362.10	382.00	+ 19.90
19	" "	Sulfur-Lead Arsenate, ...	365.54	370.00	+ 4.46
20	" "	Kil-Tone, ...	.....	368.33	.....
21	" "	Bordeaux-Lead Arsenate,	368.22	376.66	+ 8.44
22	" "	Lead Arsenate, ...	368.11	353.66	— 14.45
23	" "	Kil-Tone, ...	.....	368.00	.....
24	" "	Sulfur-Lead Arsenate, ...	357.33	359.16	+ 1.83
25	" "	Kil-Tone, ...	.....	346.66	.....

Spraying work in other parts of the State in which the results were more favorable was done on Irish Cobbler potatoes. Accordingly, it was planned to test out the various spray materials on the two varieties of potatoes in the same field. Such conditions were generously provided by Mr. Edward Winsor on his farm near Farmingdale.

The soil of this field was a sandy loam in a high state of cultivation, well adapted to potatoes. It is underlaid at a shallow depth by a greensand marl.

While it was impossible to plant the typical American Giant potatoes, the object of the experiment was not destroyed since the Aroostock Prize potatoes actually planted are very similar to the Giants in fact, most buyers fail to differentiate between the two varieties.

The experiment was carried out on 10 plots, each 4 rows wide, with the Irish Cobbler potatoes, and on 15 plots, each 8 rows wide, with the Aroostock Prize potatoes. The different treatments were duplicated on the Irish Cobblers and repeated 3 times on the Aroostock Prize.

Like all other experiments conducted this year, the Irish Cobblers received 4 applications of spray and, as was the case in 1915, it was impossible to spray the Aroostock Prize more than 3 times. The applications of spray were made on May 25, June 5, June 15, June 26. The first spray was omitted on the Aroostock Prize since these potatoes were not sufficiently large for spraying.

The relative efficiencies of the various spray materials are shown to better advantage in Table XII.

Spray Material	*Average Difference from Checks in bushels per acre*	
	Irish Cobbler	*Aroostook Prize*
Kil-Tone (Check)		
Bordeaux,	+ 43.25	+ 20.73
Lead arsenate,	+ 33.47	+ 23.94
Sulfur-lead,	+ 12.27	— 2.24

Average yield 4 Kil-Tone checks, Irish Cobblers—227.97 bushels per acre.
Average yield 6 Kil-Tone plots, Aroostook Prize—348.47 bushels per acre.

Report of the Spraying Experiment Conducted in Coöperation with Mr. H. Courtney Brown, Jamesburg, N. J.

The experiment of 1916 carried on in coöperation with Mr. Brown is almost a duplicate of the one conducted on this farm in 1915. The field of about 4 acres was divided into 22 plots of 4 rows each, the scheme of treatments being repeated 4 times.

In addition to the usual comparisons of sulfur-lead arsenate, Bordeaux and lead arsenate, it was thought advisable to use the sulfur-lead arsenate as a wet spray as well as a dust. Quite probably a better distribution of the materials is accomplished by the wet than by the dust sprayers. To learn to what extent the yields would differ, due to a more effective method of applying the spray material, this feature was included in this experiment.

The plots of this experiment were sprayed 4 times during the season and the main points of variance between this and other spraying experiments lay in the fact that the sulfur-lead arsenate was applied also as a wet spray, that a more concentrated spray material was used, and that Green Mountain potatoes were grown instead of Irish Cobblers.

The strengthening of the spray solution was necessary because the machine used was able to deliver only 75 gallons per acre instead of 100. It was desired to use the actual amount of materials applied per acre as the standard rather than gallons of spray, and hence the increase.

In preparing the wet mixture of sulfur and lead arsenate it should be noted that a very satisfactory method of wetting down the sulfur is to use a dilute solution of glue rather than plain water in preparing the paste.

The results of this experiment are shown in Table XIII.

Table XIII

Results of Spraying Experiment Conducted in Coöperation with A. Courtney Brown, Jamesburg, N. J., 1916

Plot No.	TREATMENT	Baskets Per Plot	Bu. Per Acre	Calculated Bu. Per Acre	Difference Due to Spray
1	Sulfur-Lead Arsenate (Dust),	41.5	280.8	.....	.....
2	Bordeaux-Lead Arsenate, ...	38.5	204.8	212.4	— 7.6
3	Lead Arsenate, ...	39.5	210.2	194.0	+ 6.2
4	Sulfur-Lead Arsenate (Dust),	33.0	175.6	.....	.....
5	Sulfur-Lead Arsenate (Wet),..	33.5	178.3	195.1	— 16.8
6	Bordeaux, ...	39.3	198.5	214.6	— 16.1
7	Sulfur-Lead Arsenate (Dust),	44.0	234.2	.....	.....
8	Lead Arsenate, ...	42.3	224.8	231.5	— 6.7
9	Sulfur-Lead Arsenate (Wet),..	42.0	223.5	228.8	— 5.3
10	Sulfur-Lead Arsenate (Dust),	42.5	226.1	.....	.....
11	Bordeaux, ...	47.0	250.0	213.8	+ 36.2
12	Lead Arsenate, ...	40.5	215.3	201.3	+ 14.0
13	Sulfur-Lead Arsenate (Dust),	35.5	188.8	.....	.....
14	Sulfur-Lead Arsenate (Wet),..	36.5	194.2	195.9	+ 1.7
15	Bordeaux, ...	43.5	231.3	203.0	+ 28.3
16	Sulfur-Lead Arsenate (Dust),	39.5	210.2	.....	.....
17	Lead Arsenate, ...	36.0	191.5	210.1	— 18.6
18	Sulfur-Lead Arsenate (Wet),..	38.7	206.0	209.9	— 3.9
19	Sulfur-Lead Arsenate (Dust),	41.3	209.7	.....	.....
20	Bordeaux, ...	34.0	180.9	217.9	— 37.0
21	Lead Arsenate, ...	37.5	199.7	226.1	— 26.4
22	Sulfur-Lead Arsenate (Dust),	44.0	234.2	.....	.....

The relative efficiency of these sprays is shown to better advantage in the following table:

Spray Material	*Mathematical Average, Bushels Per Acre*	*Average Difference From Calculated Yields*
Sulfur-lead (dust), ...	213.7	+ .76
Bordeaux, ...	213.1	+ .76
Lead arsenate, ...	210.3	6.30
Sulfur-lead (wet), ...	200.5	— 6.32

From the foregoing table it is quite apparent that no difference of practical importance were to be observed in the yields. It is interesting to note that on the basis of the mathematical averages of the yield on the various plots there is a difference of — 13.2 bushels per acre. On the basis of the difference between the actual and calculated yields, the average is only — 6.32 bushels per acre. Similarly, the average difference between sulfur-lead dust and lead arsenate is changed from — 3.4 to — 6.3 bushels per acre. In this case the difference is an increase, in the former a decrease. In no event are the differences especially indicative either way, but they illustrate the importance of method in interpreting the same plot yields.

The fact that the sulfur-lead arsenate was less effective when applied wet than dry is quite the reverse of what was anticipated when the work was started. It was thought that the more even distribution of the material would give an increased rather than a decreased yield. Exactly the same quantity, 30 pounds per acre, was applied by the two methods.

Report of the Potato Spraying Experiment Conducted on the Plant Pathology Plots, New Brunswick, N. J.

This experiment was designed to permit a more intimate study of the influence of Bordeaux mixture spraying on potatoes than is possible in the coöperative experiments throughout the State conducted on a commercial scale.

Instead of the plot, the hills themselves, being harvested separately, served as the basis of comparison. Variations in our previous results were possibly due, in part, to the fact that different varieties of plants may not respond in like manner to Bordeaux treatment. To see to what extent such a factor is operative we used 4 varieties of potatoes.

Three of the varieties used are undoubtedly of greatest importance within the State. They are the Irish Cobbler, Giant and Green Mountain. A fourth variety, the Jersey Red Skin, was used since interest has again been taken in this variety in certain parts of South Jersey.

Four rows of each variety of potatoes were planted, and in order to eliminate the seed as a source of variation, the seed tubers were quartered, the four pieces thus formed occupying the same position in the four different rows. The rows in this experiment were 76 feet long, each containing 38 hills placed two feet apart. The rows were 4 feet apart, allowing each hill ample room for its maximum development.

The rows of this experiment with their treatments were as follows:

Row No.	*Variety of Seed*	*Spraying Treatment*
1	Irish Cobbler,	Lead Arsenate.
2	" "	Bordeaux–Lead Arsenate.
3	Jersey Red Skin,	Lead Arsenate.
4	" " "	Bordeaux–Lead Arsenate.
5	Green Mountain,	Lead Arsenate.
6	" "	Bordeaux–Lead Arsenate.
7	American Giant,	Lead Arsenate.
8	" "	Bordeaux–Lead Arsenate.
9	Irish Cobbler,	Lead Arsenate.
10	" "	Bordeaux–Lead Arsenate.
11	Jersey Red Skins,	Lead Arsenate.
12	" " "	Bordeaux–Lead Arsenate.
13	Green Mountain,	Lead Arsenate.
14	" "	Bordeaux–Lead Arsenate.
15	American Giant,	Lead Arsenate.
16	" "	Bordeaux–Lead Arsenate.

The Irish Cobbler seed used was second-crop selected stock grown by Mr. J. Harry Kandle at Elmer, N. J. The Jersey Red Skins were grown by the Minch Bros. of Bridgeton, N. J. The Green Mountain seed was commercial seed secured from New York State. The seed used was selected for uniformity and freedom from disease from a large pile in the warehouse of Chamberlain & Barclay at Jamesburg, N. J. From Mr. D. Howard Jones at Freehold, the writer secured some of the American Giant seed grown especially for Mr. Jones in the mountainous parts of Pennsylvania.

This seed was probably of much better grade than that used in common practice, but the unfavorable soil conditions at New Brunswick did not permit of a large yield.

Table XIV

Influence of Bordeaux Spraying on First-Size Potatoes

VARIETY	Bordeaux-Sprayed			Lead Arsenate-Sprayed				
	Row No.	No. Per Hill	Average Weight of Tubers, gm.	Row No.	No. Per Hill	Average Weight of Tubers, gm.	Difference in No. Per Hill	Difference in Weight of Tubers.
Irish Cobbler, ...	2	1.380	132.3	1	1.000	118.9	+ 0.380	+ 13.4
Red Skin, ...	4	4.630	115.2	3	3.890	133.8	+ 0.740	— 18.6
Green Mountain,..	6	3.392	144.3	5	3.580	143.3	— 0.188	+ 1.0
Giant, ...	8	3.110	146.2	7	2.818	150.5	+ 0.292	— 4.3
Irish Cobbler, ...	10	3.110	132.0	9	3.405	145.6	— 0.295	— 13.6
Red Skin, ...	12	4.680	114.0	11	5.000	117.0	— 0.320	— 3.0
Green Mountain,..	14	3.945	162.3	13	3.680	180.5	+ 0.265	— 18.2
Giant, ...	16	2.392	143.0	15	2.550	177.7	— 0.158	— 34.7

The potatoes were planted on May 21 and were harvested on October 8. The plants were given 4 thorough applications of spray during the season. It would have been possible to have given more than this number of applications, but since four is the largest number of applications it is possible to make in commercial work, it was thought unadvisable to do so.

Table XV

Influence of Bordeaux Spraying on Second-Size Potatoes

VARIETY	Bordeaux-Sprayed			Lead Arsenate-Sprayed				
	Row No.	Number in Hill	Average Weight of Tubers, gm.	Row No.	Number in Hill	Average Weight of Tubers, gm.	Difference in Number Per Hill	Difference in Weight of Tubers
Irish Cobbler, ...	2	8.90	28.00	1	9.50	24.75	— 0.60	+ 3.25
Red Skin, ...	4	8.66	31.82	3	10.31	29.80	— 1.65	+ 2.02
Green Mountain,..	6	5.05	36.22	5	5.50	39.55	— 0.45	— 3.33
Giant, ...	8	5.57	27.05	7	8.21	29.68	— 2.64	— 2.63
Irish Cobbler, ...	10	5.27	37.10	9	4.57	40.40	+ 0.70	— 3.30
Red Skin, ...	12	10.20	34.30	11	12.40	31.10	— 2.20	+ 3.20
Green Mountain,..	14	7.70	35.70	13	7.87	28.10	— 0.17	+ 7.60
Giant, ...	16	7.66	35.32	15	8.28	31.32	— 0.62	+ 4.00

In harvesting, the yield of each hill was taken separately, and the tubers sorted into two grades. The total number of potatoes to each hill was taken

together with the number of first and seconds. Weighings were made on a torsion balance and weights are within 5 gm.

The results are given in Tables XIV, XV and XVI.

An inspection of the data obtained from this experiment fails to show any consistent advantage in Bordeaux spraying. While the work was done on only a relatively small number of hills, still the conditions were fairly uniform and the data on yields taken with the greatest possible accuracy.

The only indication that shows any consistency in the entire experiment is to the effect that the number of second-size tubers per hill has been decreased by Bordeaux spraying. In 7 out of a possible 8 cases, this fact is borne out. In 5 out of a possible 8 cases these second-size tubers were larger than in the corresponding lead-arsenate-sprayed hills.

Table XVI

Comparison of Total Yields

Bordeaux-Sprayed			Lead Arsenate-Sprayed			Differences Yield (1) gm.	Differences Yield (2) gm.
Row No.	Yield (1) gm.	Yield (2) gm.	Row No.	Yield (1) gm.	Yield (2) gm.		
2	6,885	9,435	1	4,400	8,695	+ 2,485	+ 740
4	20,290	10,485	3	19,800	11,655	+ 1,490	— 1,170
6	18,605	6,953	5	19,500	8,285	— 895	— 1,233
8	16,883	5,730	7	16,210	9,290	+ 673	— 3,560
10	13,880	7,280	9	18,330	6,825	— 4,450	+ 405
12	20,265	13,290	11	22,215	14,635	— 1,950	— 1,345
14	23,700	9,060	13	25,295	8,391	— 1,595	+ 669
16	13,015	10,280	15	17,405	10,095	— 4,390	+ 185

There are apparently no consistent differences in the results due to the variety of potatoes. As far as total yields are concerned, the lead arsenate rows show in 5 out of 8 cases a greater return than the corresponding Bordeaux rows.

In principle, this experiment appears to be in accordance with our best conception at the present time. Soil differences apparently played an important role in these results since the duplicate plots with the same variety of potatoes almost invariably show a reversed effect.

Report of Second-Crop Spraying Experiment Conducted in Coöperation with Mr. J. Harry Kandle, Elmer, N. J.

Very beneficial results were obtained in the second-crop spraying work in 1915. A repetition of this part of the work was, therefore, considered advisable. A field of about 8 acres was divided into 23 plots of equal sizes, each 8 rows wide.

Irish Cobbler potatoes were grown, second-crop seed kept in cold storage until late July being used for planting. Due to the fact that an improved

strain of seed was used on Plot 1, and also that no yield data were taken on Plot 16, it has been necessary to give only the mathematical averages of the yields on the various plots.

The yields on the various plots, together with the yields on the same, are shown in Table XVII.

Table XVII

Plot No.	SPRAY TREATMENT	Baskets Per Plot	Baskets Per Acre	Bushels Per Acre
1	Bordeaux-Lead Arsenate,*	114.0	299.2	187.2
2	Sulfur-Lead Arsenate,	96.0	252.	157.6
3	Lead Arsenate,	94.0	246.8	154.3
4	Bordeaux-Lead Arsenate,	93.0	244.0	152.5
5	No Spray,	90.0	236.5	147.8
6	Modified Kil-Tone,	111.0	291.5	182.3
7	Bordeaux-Lead Arsenate,	111.0	291.5	182.3
8	Kil-Tone,	117.5	308.5	192.9
9	Sulfur-Lead Arsenate,	105.5	277.1	173.3
10	Bordeaux-Lead Arsenate,	107.	281.0	175.7
11	Lead Arsenate,	93.5	245.3	153.5
12	No Spray,	98.5	258.6	161.7
13	Bordeaux-Lead Arsenate,	106.5	279.5	174.8
14	Modified Kil-Tone,	114.5	300.5	188.0
15	Kil-Tone,	103.0	270.6	169.2
16	Bordeaux-Lead Arsenate,	.....	.....	.....
17	Sulfur-Lead Arsenate,	88.0	231.0	144.4
18	Lead Arsenate,	88.5	232.3	145.3
19	Bordeaux-Lead Arsenate,	93.0	244.0	152.6
20	Modified Kil-Tone,	89.0	233.5	146.0
21	Kil-Tone,	89.0	233.5	146.0
22	Bordeaux-Lead Arsenate,	87.0	228.3	142.9
23	Kil-Tone,	92.0	241.5	151.0

* Not included because of difference in seed used.

The comparative efficiencies of the various sprays are shown to better advantage in the following table:

Spray Material	*No. of Plots*	*Average Yield.*	*Difference*
Bordeaux (check),	6	163.46	.....
Lead arsenate,	3	151.03	— 12.13
No spray,	2	154.75	— 8.71
Modified Kil-Tone,	3	172.10	+ 8.64
Kil-Tone,	4	164.77	+ 1.31
Sulfur-lead arsenate,	3	158.43	— 5.03

In 1915 the average increase for the Bordeaux plots was about 45 bushels per acre over the lead arsenate checks. This year the increase was only about one-fourth as large. In 1915, both the Colorado potato beetle and the early blight were very prevalent, and it was suggested at the time that the seemingly large increase was probably due to a control of these two pests. This year neither of these was a factor and the decreased effect of spraying would tend to confirm the previous statement. That these factors played a minor role in 1916 is further evident by the fact that the Bordeaux plots yielded only 8.71 bushels per acre more than those not sprayed.

Taken as a whole, the yields are all so close together that by the time the experimental error of the average is taken into consideration, there is no large increase in any case.

General Summary

While other phases of the potato-raising problem are probably of greater importance in a practical way, still large amounts of money are spent annually for spray materials of divers descriptions, and from the economic standpoint it is highly important that the most efficient spraying treatment be outlined.

New Jersey conditions are such that many of the principles of potato-raising, which in other States are almost axiomatic, fail to work out. Even within the confines of this relatively small State, the conditions are so variable that results obtained in one section fail of duplication in another.

Generally speaking, the spraying results at Elmer on Irish Cobblers have been quite in favor of Bordeaux mixture. The results in 1916, with an increase of about 20 bushels per acre for Bordeaux over lead arsenate, can be considered as about an average result to be expected there.

At Mount Holly the results this year, in a measure, duplicate those obtained last year. An average increase of 53.64 bushels per acre has resulted from the application of Bordeaux mixture rather than Paris green, the insecticide commonly employed. Lead arsenate shows up uncommonly well, however, with only 7.33 bushels per acre less than Bordeaux, the equivalent of 46.31 bushels per acre over Paris green. Under the conditions of this particular experiment, lead arsenate alone would have been the cheapest material one could have bought. From both the results this year and in 1915 it is quite apparent that lead arsenate as a wet spray is much more economical than Paris green as a dust.

In Monmouth County appreciable differences in yields were obtained in both Irish Cobblers and Aroostook Prize. The fact that these differences were smaller with the Prize than with the Cobblers would tend to confirm our previous opinion to the effect that the variety of the potatoes is an important contributing factor.

At Jamesburg the work on Green Mountains practically duplicates the results of 1915. No difference of economic importance has been obtained there either year. Perhaps here again variety, as well as locality, influences results.

Despite the seemingly correct method of experimentation on the plots at the College Farm, there resulted one of the most noteworthy contradictions in results of all obtained in the State. Quite probably the method of experimentation employed on the College Farm, with seed differences compensated for and yields accurately determined for each hill, gives just as indicative results as the large yield experiment.

In general, the commercial sprays have shown up well in comparison with the standard home-made Bordeaux. Mechling's Hydroxcide at Mount

Holly equalled the Bordeaux. Kil-Tone gave a slightly larger yield than Bordeaux at Elmer. It is somewhat singular that at Farmingdale and Mount Holly this material undoubtedly gave lower yields than Bordeaux, and yet at Elmer, in case of both the first and second crop potatoes, the yields were slightly larger than with Bordeaux. Pyrox in the one experiment gave a slightly lower yield than Bordeaux, but when it is considered that the difference is not more than twice the experimental error, there is nothing detrimental to be said of the spray.

Due to the fact that Tuber-Tonic was used in larger amounts than is recommended, it would be unfair to accept the results as indicative of the true merit of this material.

The sulfur-lead arsenate mixture is not as effective as Bordeaux. This could not be expected from any dust mixture. Undoubtedly, better results are obtained from this mixture than from straight Paris green, and when it is considered that in a certain period of time one can dust from three to four times the acreage that can be covered in spraying, it appears that under certain conditions of labor shortage it would be more economical to dust than to spray.

A very thorough application of dust can be made with certain machines now on the market and the problem of dust or spray applications rests on a very careful analysis of the economic factors.

Roughly speaking, the dusting costs about half as much as spraying with home-made Bordeaux. Sulfur dusting costs approximately twice as much as Paris green, but the results thus far point to the superiority of the sur-fur-lead arsenate mixture.

The past season has not been especially favorable for obtaining large differences. Both insect and fungous pests were at a minimum and the seasonal conditions being especially conducive to growth, would make any increasing of the yield all the more difficult.

The variability of results at different points of the State is again demonstrated. Unquestionably, a better spraying system than the use of Paris green can be devised in some section of the State, particularly on Irish Cobblers. Lead arsenate alone has so closely approximated Bordeaux in several experiments this year that it was undoubtedly the cheapest spray under those especial conditions. For convenience, the commercial preparations have many points in their favor.

The complete answer to the potato-spraying problem cannot be said to have been achieved. Seasonal differences and climatic differences in various parts of the State play such an important role that the evidence of several years more will be necessary before the most economical spraying treatments are determined.

XIV

REPORT OF THE SULFUR–POTATO SCAB EXPERIMENTS 1916

H. CLAY LINT

Experiments on the use of sulfur for the control of potato scab (*Actinomyces chromogenus* Gaspini) which were started in 1914 have been continued during the past season. The work has been practically a duplication and continuation of the work of the two previous years.

Six coöperative experiments were carried out in various parts of the State on the farms of the following men: Mr. Walter Minch, Bridgeton; Mr. M. F. Riley, Elmer; Mr. H. W. Ridgeway, Bridgeton; Mr. W. J. MacFarland, Burlington; Mr. J. Carroll Burtis, Allentown; Mr. Earl Dilatush, Robbinsville.

The first four of these experiments were simply repetitions of the 1915 experiments on the same plots. It was also planned simply to repeat the previous experiments on the farms of Mr. Burtis and Mr. Dilatush, respectively, but conditions this spring forbade such procedure and the experiments this year were necessarily carried out on different soil.

In general, the experiment of the past summer provides very satisfactory confirmation of the tentative conclusions submitted on the previous work. Three different sets of climatic conditions have been encountered in the work. The summer of 1914 was essentially dry, 1915 was more moist than usual, while the past season might well be regarded as normal. That the results from sulfur applications for scab control should have shown this degree of consistency permits of a broader generalization than would otherwise have been the case.

The experiments may better be considered separately. Irish Cobbler potatoes were grown on all experiments since this variety is particularly susceptible and is economically the most important.

Report of Experiment in Coöperation with Mr. W. J. MacFarland, Burlington, N. J.

The experiment in coöperation with Mr. MacFarland near Burlington has been carried out according to the plan outlined in the Annual Report of the Experiment Station for 1915. The individual plots were each 100 feet long by 4 rows wide, arranged in 8 parallel strips each 4 plots long. As in all of our experiments the plan has been to have check plots adjacent to each treated plot. The calculated yields and percentage of clean tubers have been completed for the treated plots on the basis of these checks, and the actual benefit is taken as the difference between this theoretical figure and that actually obtained.

The yields were calculated in the same manner as previously reported. In this particular experiment practically the entire yield of the first size tubers was sorted.

The results of the experiments at Burlington are shown in Table XVIII.

Table XVIII

Results of Potato Scab Experiment Conducted in Coöperation with Mr. W. J. MacFarland, Burlington, N. J., Summer of 1916

Plot No.	Seed Treatment	Sulfur, Pounds Per Acre		Actual Percentage of Clean Tubers	Calculated Percentage of Clean Tubers	Effect of Sulfur on Percentage of Scab	Actual Yield, Bushels Per Acre	Calculated Yield, Bushels Per Acre	Effect of Sulfur on Yield, Bushels Per Acre
		1915	1916						
1	Formalin,	Check	Check	37.65	.....	.....	123.25	.....	.....
2	Formalin,	Check	Check	40.15	.....	.....	129.08	.....	.....
3	Formalin,	Check	Check	46.80	.....	.....	108.24	.....	.....
4	Formalin,	Check	Check	43.80	.....	.....	133.51	.....	.....
5	Formalin,	600	600	56.55	44.45	+12.10	97.00	114.08	-17.08
6	Formalin,	300	300	53.23	45.79	+ 7.44	92.41	115.68	-23.27
7	Formalin,	600	600	54.45	52.33	+ 2.12	60.37	106.16	-45.79
8	Formalin,	300	300	65.20	49.05	+16.15	132.61	133.73	+ .12
9	Formalin,	600	Check	47.92	53.25	- 5.33	67.26	104.91	-37.65
10	Formalin,	300	Check	56.50	51.43	+ 5.07	81.02	102.27	-21.25
11	Formalin,	600	Check	55.00	58.36	- 3.36	82.78	104.04	-21.27
12	Formalin,	300	Check	66.75	54.30	+12.45	148.53	133.95	+14.58
13	Formalin,	Check	Check	58.06	.....	.....	95.74	.....	.....
14	Formalin,	Check	Check	57.08	.....	.....	88.86	.....	.....
15	Formalin,	Check	Check	64.40	.....	.....	101.96	.....	.....
16	Formalin,	Check	Check	59.56	.....	.....	134.16	.....	.....
17	Not Treated,	Check	Check	61.35	.....	.....	96.36	.....	.....
18	Not Treated,	Check	Check	60.63	.....	.....	99.06	.....	.....
19	Not Treated,	Check	Check	55.85	.....	.....	74.48	.....	.....
20	Not Treated,	Check	Check	59.80	.....	.....	79.36	.....	.....
21	Not Treated,	600	600	61.40	56.84	+ 4.56	111.96	92.86	+19.10
22	Not Treated,	300	300	65.20	55.79	+ 9.41	112.25	96.37	+15.88
23	Not Treated,	600	600	73.15	49.78	+23.37	98.04	79.90	+18.14
24	Not Treated,	300	300	72.82	53.83	+18.99	101.45	81.26	+20.19
25	Not Treated,	600	Check	49.75	52.33	- 2.58	86.64	89.36	- 2.72
26	Not Treated,	300	Check	51.85	50.97	+ 0.88	87.24	93.68	- 6.44
27	Not Treated,	600	Check	49.75	52.81	- 3.06	76.81	85.32	- 8.51
28	Not Treated,	300	Check	60.88	56.56	+ 4.32	71.69	83.16	-11.47
30	Not Treated,	Check	Check	46.15	.....	.....	85.86	.....	.....
31	Not Treated,	Check	Check	46.75	.....	.....	90.99	.....	.....
32	Not Treated,	Check	Check	51.10	.....	.....	90.78	.....	.....
.....	.....	.....	.....	.....	.....	.....	85.07	.....	.....

The more apparent features in these results are: (1) The annual application of 300 pounds of sulfur per acre gives as effective control of scab as one of 600 pounds per acre. (2) Where applications of 300 pounds were made in 1915 the scab control the following year has been even better than where heavier applications were made. (3) It is somewhat peculiar, in view of the results on other plots, to note an increased yield on the plots planted with untreated seed to which sulfur was applied in both 1915 and 1916. The mere fact, however, that 10 out of 16 plots variously treated with sulfur during the two years should show a decreased yield conforms with the results generally noted. (4) Little difference in the amount of scab is to be seen where the treated and the untreated seed were used. It should be noted, in this connection, that on the whole the crop here was very clean and the sorting exceptionally close. The difference either way would have been of no practical importance.

Report of the Experiment in Coöperation with Mr. Walter Minch, Bridgeton, N. J.

This experiment was an exact duplication of the one carried out at Burlington. The corrosive sublimate treatment of the seed was substituted for formalin. Due to the large rainfall in 1915 the results of this experiment were influenced somewhat by faulty topography. In the normal year of 1916 such differences were not apparent, and the results show more nearly the probable effect of sulfur in this vicinity. Second-crop seed grown by Mr. Minch was used.

The results of this experiment are shown in Table XIX.

Table XIX

Results of Sulfur-Potato Scab Experiment Conducted in Coöperation with Mr. Walter Minch, Bridgeton, N. J., Summer of 1916

Plot No.	Seed Treatment	Sulfur, Pounds Per Acre		Actual Percentage of Clean Tubers	Calculated Percentage of Clean Tubers.	Difference.	Actual Yield, Bushels Per Acre.	Calculated Yield, Bushels Per Acre	Difference, Bushels Per Acre
		1915	1916						
1	$HgCl_2$,	Check	Check	39.92	.....	.....	203.66	.....	.....
2	$HgCl_2$,	Check	Check	48.08	.....	.....	229.00	.....	.....
3	$HgCl_2$,	Check	Check	54.35	.....	.....	188.08	.....	.....
4	$HgCl_2$,	Check	Check	51.35	.....	.....	142.16	.....	.....
5	$HgCl_2$,	600	600	61.70	.....	+28.08	194.75	217.88	-23.13
6	$HgCl_2$,	300	300	59.30	33.62	+ 9.19	214.83	240.55	-25.72
7	$HgCl_2$,	600	600	62.88	50.11	+ 7.83	204.55	206.66	- 2.11
8	$HgCl_2$,	300	Check	59.85	55.05	+ 6.51	202.83	168.66	+34.17
9	$HgCl_2$,	600	Check	43.20	53.34	+15.87	211.58	232.10	-20.52
10	$HgCl_2$,	300	Check	58.60	27.33	+ 6.46	233.66	252.10	-18.44
11	$HgCl_2$,	600	Check	58.72	52.14	+ 2.98	207.00	225.24	-18.24
12	$HgCl_2$,	300	Check	53.40	55.75	- 1.97	193.83	195.16	- 1.33
13	$HgCl_2$,	Check	Check	21.04	55.33	.....	246.33	.....	.....
14	$HgCl_2$,	Check	Check	54.18	.....	.....	263.66	.....	.....
15	$HgCl_2$,	Check	Check	56.45	.....	.....	243.83	.....	.....
16	$HgCl_2$,	Check	Check	57.33	.....	.....	221.66	.....	.....
17	$HgCl_2$,	Check	Check	20.45	.....	.....	180.08	.....	.....
18	Untreated,	Check	Check	30.88	.....	.....	222.14	.....	.....
19	Untreated,	Check	Check	38.72	.....	.....	191.66	.....	.....
20	Untreated,	Check	Check	47.26	.....	.....	183.33	.....	.....
21	**Untreated,**	600	600	27.78	16.16	+11.62	191.66	182.25	+ 9.61
22	Untreated,	300	300	24.65	23.61	+ 1.04	164.33	216.26	-51.93
23	Untreated,	600	600	29.81	30.69	- 0.88	179.33	184.80	- 5.47
24	Untreated,	300	300	23.73	36.97	-13.24	171.83	184.75	-12.92
25	Untreated,	600	Check	19.92	11.87	+ 8.05	153.50	184.02	-30.52
26	Untreated,	300	Check	17.00	16.33	+ 0.67	120.10	210.38	-90.28
27	Untreated,	600	Check	28.56	22.65	+ 5.91	204.50	177.94	-26.56
28	Untreated,	300	Check	22.07	26.71	- 4.64	223.58	186.17	+37.41
29	Untreated,	Check	Check	7.58	.....	.....	186.00	.....	.....
30	Untreated,	Check	Check	9.05	.....	.....	204.50	.....	.....
31	Untreated,	Check	Check	14.61	.....	.....	171.08	.....	.....
32	Untreated,	Check	Check	16.43	.....	.....	187.58	.....	.....

* $HgCl_2$ is Corrosive Sublimate.

The results of this experiment more nearly coincided with those previously obtained. The more important features to be noted are as follows:

(1) The corrosive-sublimate-treated seed gave a yield which is roughly 25 to 30 per cent cleaner than that obtained from the untreated seed. Likewise, there is apparently a larger yield from the treated than from the untreated seed.

(2) The application of sulfur has resulted in a decreased yield. Such a wide variation exists in the amount of this decrease that one could not say that the second-year application had resulted in an additional decrease.

(3) In general, the decreased amount of scab is correlated with the increased rate of application. This is much more apparent in the second year when no additional sulfur was applied. The results from the second-year applications are somewhat irregular but apparently there is no marked difference between the heavy and light applications when continued through the second year.

Report of the Experiment in Coöperation with Mr. H. W. Ridgeway, Bridgeton, N. J.

This experiment represents the second-year work as previously outlined. It was unfortunate that through an error the entire area occupied by the experiment was not again planted to potatoes so that the entire plot scheme was not repeated.

The object of this experiment was to test the efficiency of limestone and sulfur mixtures for the purpose of eliminating some of the undesirable features attendant upon the use of pure sulfur. The differences obtained in 1915 were too slight to merit very definite conclusions.

While some discrepancies exist in the data as shown in Table XX, the results are on the whole quite promising.

Several instances are to be noted where the sulfur and limestone mixtures have increased the yield quite materially. But it will also be observed that sulfur alone once increased the yield and limestone alone decreased it. Such an occurrence renders very definite conclusions invalid.

(1) Due to the fact that the plot treatments could not be repeated, it is impossible to state the influence of the sulfur and limestone mixtures on the yields.

(2) In the control of scab the pure sulfur gives only slightly better results than the limestone mixtures.

(3) Sulfur alone is less effective on plots limed in 1915 than where no lime was applied.

(4) The application of limestone has not favored the development of scab to the extent that might have been expected.

Table XX

Results of Sulfur-Potato Scab Experiment in Coöperation with Mr. H. W. Ridgeway, Bridgeton, N. J., Summer of 1916

Plot No.	Treatment, Pounds Per Acre		Yield in Bushels Per Acre			Percentage of Clean Tubers		
	1915	1916	Actual	Calculated	Difference	Actual	Calculated	Difference
1	Check	Check	175.83	.....	.....	44.30	.....	.....
2	Check	Check	166.66	.....	.....	45.36	.....	.....
3	Check	Check	172.50	.....	.....	40.91	.....	.....
4	Check	Check	165.66	.....	.....	39.45	.....	.....
5	Check	Check	180.25	.....	.....	38.20	.....	.....
6	Check	Check	182.75	.....	.....	34.82	.....	.....
7	Check	Check	197.33	.....	.....	35.46	.....	.....
8	Check	Check	210.66	.....	.....	29.70	.....	.....
9	Check	Check	227.33	.....	.....	38.34	.....	.....
10	[1]S. 600	S. 600	193.16	197.41	- 4.25	60.85	48.16	+12.69
11	S. 600 [2]L. 600	S. 600 L. 600	185.66	194.88	+ 9.22	56.08	40.25	+15.83
12	L. 300 S. 600 L. 300	L. 300 S. 600 L. 300	201.66	197.78	+ 4.04	47.24	37.10	+10.14
13	Limestone 300	S. 600	222.08	195.55	+26.53	44.20	39.00	+ 5.20
14	L. 600	S. 600	202.33	190.61	+11.72	42.5	37.70	+ 4.80
15	S. 600	L. 300 S. 600	171.66	185.44	-13.78	30.45	32.54	- 2.09
16	S. 600	L. 600 S. 600	178.25	204.10	-25.85	43.25	36.22	+ 7.03
17	Check	S. 600	228.83	227.56	+ 1.27	58.40	37.20	+21.20
18	Check	S. 600 L. 300	246.58	229.33	+17.25	55.05	36.71	+18.34
19	S. 600	Check	239.18	218.99	-20.09	55.28	52.02	+ 3.26
20	S. 600 L. 600	Check	234.16	224.10	-10.06	35.80	35.15	+ .65
21	S. 600 L. 300	Check	228.16	223.06	- 4.90	36.86	33.30	+ 3.56
22	L. 300	Check	209.33	225.44	-16.11	45.20	38.56	+ 6.44
23	S. 600 L. 300	L. 300 Check	219.41 211.33	188.13 200.97	+31.28 +10.36	27.39 31.08	30.27 37.20	- 2.88 - 6.12
25	S. 600	L. 600	197.66	210.87	-13.21	32.18	38.22	- 6.04
26	Check	L. 600	177.16	244.56	-67.40	47.27	44.70	+ 2.57
27	Check	L. 600 S. 600	227.66	231.33	- 3.67	52.30	35.08	+17.22
28	Check	Check	240.66	.....	.....	55.90	.....	.....
29	Check	Check	254.33	.....	.....	30.05	.....	.....
30	Check	Check	258.33	.....	.....	29.50	.....	.....
31	Check	Check	255.33	.....	.....	38.12	.....	.....
32	Check	Check	221.50	.....	.....	36.70	.....	.....
33	Check	Check	191.66	.....	.....	28.00	.....	.....
34	Check	Check	217.66	.....	.....	39.64	.....	.....
35	Check	Check	261.57	.....	.....	52.20	.....	.....
36	Check	Check	233.33	.....	.....	33.45	.....	.....

[1] S—Sulfur. [2] L—Lime.

Experiment in Coöperation with Mr. Earl Dilatush, Robbinsville, N. J.

It was impossible to continue the work on the soil under experiment in 1915 at Robbinsville, and because of the unsatisfactory results obtained from the sulfur-limestone mixtures, it was thought advisable to substitute a test of this material here.

The soil type and general management on this field is the same as previously reported. The experiment consisted of 7 plots each 200 feet long and 4 rows wide. Their arrangement and treatment is shown in Table XXI.

This plot was about the last planted by Mr. Dilatush in the spring and a mixed stand of Irish Cobblers and Green Mountains resulted. On the whole, the amount of scab did not vary greatly with variety, and little error in the result can be attributed to this source.

Table XXI

Results of Sulfur-Potato Scab Experiment in Coöperation with Mr. Earl Dilatush, Robbinsville, N. J. Summer of 1916.

Plot No.	Treatment, Pounds Per Acre	Yield in Bushels Per Acre			Percentage of Clean Tubers		
		Actual	Calculated	Difference	Actual	Calculated	Difference
1,	Check,	222.00	.....	.....	30.00	.....	.....
2,	Sulfur, 600,	208.33	214.42	-6.09	29.35	24.44	+4.89
3,	Check,	206.83	.....	.....	18.88	.....	.....
4,	Sulfur, 600, Limestone, 300,	201.50	216.75	-15.25	34.92	27.24	+7.68
5,	Check,	226.66	.....	.....	35.59	.....	.....
6,	Sulfur, 600, Limestone, 600,	222.83	259.66	+36.83	28.48	34.33	-5.85
7,	Check,	282.66	.....	.....	33.07	.....	.....

No real decrease in the yields due to any of the treatments can be claimed. With the exception of Plot 7, all of the plots show as great regularity in yield as is usually to be obtained if all the plots are alike. The abnormally large yield on Plot 7 makes an apparent increased yield on Plot 6. A glance at the yields of the first six plots will show that the actual yield on Plot 6 is probably the normal yield.

In the matter of scab control the actual differences either way are too small to warrant serious consideration. Just why sulfur alone should be less effective than a mixture of sulfur and limestone, 2 to 1, is not apparent, particularly so since the 1 to 1 mixture shows more scab than the calculated percentage. It might be possible for the extra 300 pounds of limestone per acre actually to cause this reversal, but it hardly seems probable.

Experiment in Coöperation with Mr. J. Carroll Burtis, Allentown, N. J.

Very much the same conditions prevailed at Allentown as at Robbinsville and another test of the sulfur-limestone mixture was substituted in place of the one already started.

The plots of this experiment were 300 feet long and 4 rows wide. More soil was available here and an additional plot for limestone alone made this experiment more complete.

The results of the experiment are shown in Table XXII.

Table XXII

Results of Sulfur-Potato Scab Experiment Conducted in Coöperation with Mr. J. Carroll Burtis, Allentown, N. J. Summer of 1916

Plot No.	Treatment, Pounds Per Acre	Yield in Bushels Per Acre			Percentage of Clean Tubers		
		Actual	Calculated	Difference	Actual	Calculated	Difference
1,	Check.	127.80*	.....	.....	35.82	.....	.....
2,	Limestone, 300, .. Sulfur, 600, ...	143.91	132.02	+11.89	34.78	27.55	+7.23
3,	Check, ...	136.25	.....	.....	91.28	.....	.....
4,	Sulfur, 600, ...	143.91	148.04	- 4.13	28.55	20.28	+8.27
5,	Check, ...	159.83	.....	.....	21.28	.....	.....
6,	Sulfur, 600, ... Limestone, 600, ..	183.58	149.70	+33.88	21.35	14.92	+6.43
7,	Check, ...	139.58	.....	.....	8.57	.....	.....
8,	Limestone, 600, ..	197.66	139.58	+58.08	2.04	8.57	-6.53

The results of this experiment show a very consistent effect of both the sulphur and the limestone. In fact, this experiment is the only one of the five of this type showing such tangible results. Limestone alone increased the yield 58 bushels per acre, and regularly as the quantity is decreased the yield is decreased.

In the control of scab, the percentage of clean tubers decreases as the amount of limestone is increased. The actual differences are small, but they are significant in view of the fact that the limestone alone has increased the amount of scab by 6 per cent.

Report of the Experiment in Coöperation with Mr. M. F. Riley, Elmer, N. J.

This experiment is a continuation of the one started here in 1915. The object of the work was to determine the influence of the various methods of application on the efficiency of sulfur. The results of this experiment last year showed very marked differences due to these factors.

The results this year, as shown in Table XXIII, confirm in a large measure, the conclusions drawn from the previous work.

The following points are apparent from the data of this experiment:

(1) Broadcasting of the sulfur before planting is apparently the most efficient means of applying sulfur.

(2) The use of sulfur in mixture with the fertilizer, while effective in the control of scab, results in an abnormally large decrease in the yield. Such a mixture of fertilizer with a large quantity of sulfur is not to be recommended.

(3) Broadcasting of the sulfur before planting has brought about an increase in the yields.

(4) Applications of sulfur a second season brought about a decrease in the amount of scab and also a decrease in the yield.

Table XXIII

Results of Sulfur-Potato-Scab Experiment Conducted in Coöperation with Mr. M. F. Riley, Elmer, N. J., Summer of 1916

Plot No.	Sulfur, 600 Pounds Per Acre		Percentage of Clean Tubers			Yield in Bushels Per Acre		
	1915	1916	Actual	Calculated	Difference	Actual	Calculated	Difference
1	Check,	Check,	18.10			142.0		
2	Mixture with fertilizer,	Mixture with fertilizer,	69.85	20.22	+ 49.63	62.50	142.22	- 79.72
3	Mixture with fertilizer,	Check,	46.10	22.34	+ 23.76	147.91	144.44	- 3.47
4	Check,	Check,	24.47			142.66		
5	Broadcast after planting,	Same,	25.57	23.28	+ 2.29	123.50	129.70	- 6.20
6	Broadcast after planting,	Check,	22.07	22.10	- .03	130.86	117.35	+ 13.51
7	Check,	Check,	20.92			105.00		
8	Broadcast before planting,	Same,	72.86	19.21	+ 53.65	120.58	105.88	+ 14.70
9	Broadcast before planting,	Check,	33.15	17.52	+ 15.63	139.50	106.76	+ 32.74
10	Check,	Check,	15.88			107.66		
11	Check,	Broadcast before planting,	47.80	14.14	+ 33.66	161.0	107.66	+ 53.34

(5) The second year influence of sulfur in the control of scab is very perceptible in this experiment.

This phase of the experimental work of the Department is more briefly reported this season than heretofore, in view of the fact that a complete resumé of the entire investigation is to be prepared in the form of a bulletin. The general summary and recommendations are reserved for that publication.

Fig. 1.—Bean Anthracnose (*Colletotrichum lindemuthianum*). Photo by H. B. North.

Fig. 2.—Grape Rot (*Melanconium fuligineum*). Photo by W. S. Krout.

PLATE II.

Fig. 7.—Bacterial disease of peach (*B. Pruni*). Photo by Prof. M. A. Blake.
(From N. J. Agr. Exp. Sta. Circ. 81.)

Fig. 1.—Bacterial disease of peach (*B. pruni*). Photo by C. H. Connors.

Fig. 2.—Bacterial disease of peach (*B. pruni*). Photo by C. H. Connors.

Fig. 1.—Pepper mosaic.

Fig. 2.—Early blight of the potato (*Alternaria solani*).

PLATE IV.

PLATE V.

Fig. 2.—Poplar twig blight (*Dothichiza populæ*). Photo by C. H. Connors.

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REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
OCTOBER 31, 1917

Union Hill, N. J.
HUDSON PRINTING COMPANY
1918

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*
WILLIAM H. MARTIN, M.SC., *Research Assistant.*
*WEBSTER S. KROUT, M.SC., *Research Assistant.*
†ROBERT F. POOLE, B.SC., *Research Assistant.*

*Resigned April 1, 1917.
†Appointed May 1, 1917.

CONTENTS

	PAGE
ORGANIZATION	523
INVESTIGATIONS	523
EPIDEMICS	524
PLANT DISEASE SURVEY	525
NEEDS	525
THE HERBARIUM	525
PUBLICATIONS	526
INSPECTION	526
MOST COMMON DISEASES OF THE YEAR	527
REPORT OF CELERY INVESTIGATION	536
TOMATO SPRAYING EXPERIMENTS AT RIVERTON, N. J.	540
Spray Mixtures Used	541
Spraying Machinery	542
Plan of the Experiments	544
Field Tests	544
Use of Traction and Power Sprayers	552
Effect of Late Applications	554
Effect of Spraying Late Tomatoes	557
POTATO SPRAYING EXPERIMENTS IN 1917	561

Report of the Department of Plant Pathology

MELVILLE THURSTON COOK, PH.D.

ORGANIZATION

The organization of the department has undergone a considerable change since our last report. Mr. W. H. Martin, M.Sc., continues with us as assistant. Mr. W. S. Krout, M.Sc., resigned April 15 to accept a position as assistant plant pathologist in the Massachusetts Agricultural Experiment Station. His place was filled by Mr. R. F. Poole, B.Sc., of Clemson College, South Carolina, who assumed his duties on May 1. Mr. C. M. Haenseler, M.Sc., who held the Fellowship established by the New Jersey Zinc Company for the study of fungi injurious to plants, was called to the Colors September 8. Mr. C. A. Schwarze continues as assistant state plant pathologist employed by the New Jersey State Department of Agriculture.

INVESTIGATIONS

The special investigations for the year have been as follows:

1. The study of diseased potato seed for the purpose of determining the influence of certain diseases on the yield. This work has been carried on for the past three years: in 1915 and 1916 by the writer assisted by Dr. H. C. Lint, and in 1917 by the writer assisted by Mr. Haenseler and Mr. Poole. A discussion of the results obtained is appended to this report.

2. A study on spraying potatoes for the control of diseases. This is a continuation of the work conducted by Dr. H. C. Lint in 1915 and 1916. The work was on the farms of Mr. J. Harry Kandle, Elmer, N. J., and Mr. T. M. Appleby, Dayton, N. J. Mr. Irving L. Owen, County Demonstrator for Middlesex County, gave most hearty cooperation in the work on Mr. Appleby's farm. A discussion of this work is appended to this report.

3. The spraying of tomatoes for the control of plant diseases. This work was in cooperation with the Bureau of Plant Industry, of the United States Department of Agriculture and the Campbell Soup Company. The work was conducted on the Campbell Soup Company Farm at Moorestown, N. J., and was under the immediate direction of Mr. W. H. Martin assisted by Mr. D. H. Davenport. A discussion of this work is appended to this report.

4. A study of fungi injurious to paints by Mr. C. M. Haenseler. Good progress was made with this problem but the work was not carried far enough to justify the publication of a report at this time.

5. A study of the diseases of celery by Mr. R. F. Poole. This work was conducted on the farm of Tunis Drenth, Oradell, N. J. A discussion is appended to this report.

6. We also started a number of minor problems which it may be necessary for us to discontinue for want of necessary assistants.

EPIDEMICS

There were no very pronounced epidemics in 1917 although there was considerable loss due to plant diseases. In the early part of the season the conditions were exceptionally good for plant production, but heavy rains about the middle of July were followed by a great many complaints. In the early part of the season the potato crop was exceptionally free from injurious diseases, but immediately following the heavy rains there was an unusual amount of tip burn, which was followed with an exceptionally large amount of early blight. The result was a loss ranging from 25 to 40 per cent in different parts of the state. In this connection it is worth noting that the loss was, as a rule, less on the crops where carefully selected or certified seed was used than on those grown from the market run of seed. It is also worthy of note that the loss was less on crops on good soils and on those which were well fertilized than on poor soil and on land where a small amount of fertilizer was used.

The department also received complaints concerning an unsatisfactory condition of peppers growing in the vicinity of Newfield. An investigation showed that on many farms the plants were small and frequently with poor root systems. In many cases there was a tendency to drop the foliage and blossoms. A careful

investigation failed to reveal any organism or soil condition to which this could be attributed. This is a problem which should receive careful attention another year.

We received a great many complaints concerning the scalding of maple leaves. This was no doubt due to physiological conditions.

We also received a great many reports of a bacterial disease of corn. This is apparently the same disease that was originally described by Prof. Burrill of Illinois in 1889. It has been observed by Dr. B. D. Halsted and others in New Jersey for several years, but was somewhat more severe this year than in the past.

PLANT DISEASE SURVEY

The war conditions have emphasized the importance of both a national and a state plant disease survey. These surveys should indicate the relative importance of disease in various parts of the state and nation. They should be made by trained plant pathologists who have an appreciation of the agricultural interests of the state. They should be of such character as to facilitate the research work of the agricultural experiment stations, also the demonstration work of the extension division.

NEEDS

In addition of the need of a careful and thorough plant disease survey which should be continued from year to year, we are in need of work on the following problems.

1. A study of the diseases of the potato.
2. A study of the diseases of the tomato.
3. A study of the diseases of legumes.
4. A study of the diseases of grains.
5. Studies on the many diseases of truck crops.
6. Studies on the many diseases of ornamental crops.

THE HERBARIUM

Unfortunately the herbarium has been neglected for many years. The mounted plants should be gone over carefully and put in place. Several hundred unmounted plants should be mounted and carefully distributed so that they can be used. This work should be carried on in connection with the plant disease survey.

PUBLICATIONS

The following publications have been issued during the past year:

Circular 68. Common Diseases of Cucumbers and Melons.
William H. Martin.

Circular 71. Diseases of Tomatoes.
Mel. T. Cook and William H. Martin.

Circular 75. Spray Calendar for Apples and Quinces.
" 76. Spray Calendar for Pears.
" 77. Spray Calendar for Sweet Cherry.
" 78. Spray Calendar for Plum.
" 79. Spray Calendar for Peach.
T. J. Headlee, Mel. T. Cook and M. A. Blake.

Circular 80. Common Diseases of Apples, Pears and Quinces.
" 81. Common Diseases of Peach, Plum and Cherry.
" 84. Common Diseases of Beans and Peas.
Mel. T. Cook.

INSPECTION

The inspection work which is under the direction of the New Jersey State Department of Agriculture has been reorganized and Mr. H. B. Weiss appointed chief inspector with general supervision over the details of the inspection work for both insects and plant diseases.

During the spring and summer we were assisted in scouting for the blister rust of the white pine by two special inspectors sent to us by the United States Bureau of Plant Industry. The disease was not found in any of the blocks of stock which were placed under quarantine in 1916, but was found in one other block of stock, which has also been placed under quarantine. One of the scouts also found a considerable amount of wild *Ribes* (alternate host) in Sussex County but fortunately the disease has not made its appearance in that locality.

This disease has been the subject of numerous quarantines by the United States Department of Agriculture and by a number of states during the past year. The character of this disease and the strenuous efforts of the Federal Government and the various states to eradicate it justify us in continuing our quarantines on the blocks of white pines in which the disease has been found.

MOST COMMON DISEASES OF THE YEAR

The following is a list of the diseases collected by members of this and other departments and sent in by the growers.

Alfalfa

LEAF SPOT (*Pseudopeziza medicaginis* [Lib.] Sacc.). This disease continues with about equal severity from year to year. It is probably correlated with quality of seed but may also be correlated with soil conditions.

WHITE SPOT (Cause undetermined). Prevalent but not serious. We also find a similar spotting on the clovers.

LEAF SPOTS (*Pleospora* sp., *Cercospora medicaginis* E. E. and *Stagnospora carpathica* Baulm). Occasional.

Several undetermined leaf spots which may have been incipient stages of some of the above, or due to some other causes, were sent in from time to time.

Ampelopsis

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of the ivy plants on buildings, and was a very serious pest in the nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata.*

DIE BACK (*Cladosporium* sp.). This disease occurs on the *A. tricuspidata.* It was much less severe than in 1915.

Apple

JONATHAN SPOT (*Alternaria* sp.) A peculiar spotting of the Jonathan is without doubt due to this organism. It continues to be equally severe from year to year.

Other very similar spots are no doubt due to other causes. The study of these minor apple spot rots is of greater importance than is at first apparent. They no doubt serve as points of infection for other and more serious rot organisms. The minor spot rots in their relation to the more serious rots should be the subject of a very careful and thorough study.

BLOSSOM END ROT (*Alternaria* sp.). This disease continues to cause more or less trouble with many varieties. It is frequently associated with black rot.

ANTHRACNOSE OR BITTER ROT (*Glomerella rufomaculans* [Berk.] S. & Von S.). A few records. It is of very little importance in orchards that are properly sprayed.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards. It frequently appears as a blossom end rot but should not be confused with the *Alternaria* blossom end rot.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). This disease was less destructive than in 1916.

BLOTCH (*Phyllosticta solitaria* E. & E.) This disease has been very severe on some varieties, especially Smith's Cider, but no more severe than in previous years.

SOOTY BLOTCH (*Phyllachora pomigena* [Schw.] Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* [Mont. & Fr.] Sacc.). This disease was prevalent throughout the state, but did not reach the proportion of an epidemic.

BROWN ROT (*Sclerotinia fructigena* [Per] Schr.). Occasional.

PINK ROT (*Cephalothecium roseum* Cda.). Common.

LEAF SPOTS (*Phyllosticta pyrina* Sacc. and *Sphaeropsis malorum* Pk.). Common and about as severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the state. (*G. globosum*). Occasional.

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith and Townsend). This very common disease is receiving more attention from nurserymen and growers. We have had several reports concerning it.

WATER CORE. Occasional.

SPRAY INJURY. Occasional.

WINTER INJURY. More or less common throughout the state.

Asparagus

RUST (*Puccinia asparagi* De C.). Occasionally, but not in sufficient quantity to be of importance.

Aster

YELLOWS. This disease, which is due to an unknown cause, occurred in many places and was very destructive. We have had a smaller number of complaints than usual.

Barley

SMUT (*Ustillago nuda* [Jens.] Kell & Sw.). Very common and in some cases very abundant.

POWDERY MILDEW (*Erysiphe graminis* D. C.). Occasional.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* [Sacc. & Magn.] Bri. & Cav.). This disease was more or less common but was not the cause of many complaints.

LEAF SPOT (*Phyllosticta phaseolina* Sacc.). This disease was quite common on the leaves of lima beans.

POD SPOT (*Phoma subcircinata* E. & E.). This disease was quite common on the leaves of lima beans.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Occasional.

ROOT ROT (*Rhizoctonia* sp.) This organism is frequently present in cankers on the stems. It was frequently associated with *C. lindemuthianum.*

RUST (*Uromyces appendiculatus* [Pers.] Lev.). Occasional.

BACTERIAL BLIGHT (*Pseudomonas phaseoli* E. F. Smith). This disease was quite prevalent in the early part of the season on the seedlings and was very destructive. It was less destructive later in the season.

POOR FRUITING (Cause unknown). We had several inquiries concerning the setting of pods which did not produce seeds. This was apparently due to lack of pollination.

Beet

LEAF BLIGHT (*Cercospora beticola* Sacc.). Quite common.

ROOT ROT (*Phoma betae* Frank). This rot has been found in a few cases in both fields and storage.

Blackberry

ANTHRACNOSE (*Gloesporium venetum* Speg.). Common and destructive in many places.

LEAF SPOT (*Septoria rubi* West.). Common.

RUST (*Gymnoconia peckiana* [Howe] Tranz.). Common.

Cabbage, Cauliflower and Kohlrabi

CLUB ROOT (*Plasmodiophora brassicae* Wor.). The reports indicate that this disease was more prevalent than usual.

BLACK ROT (*Pseudomonas campestris* [Pammel] Smith). Reported frequently, and in most cases very destructive.

DAMPING OFF (*Rhizoctonia* and *Fusarium*). Several reports.

YELLOWS (*Fusarium conglutinans* Wollenw.). Common and sometimes destructive.

Cantaloupe

See Muskmelon.

Carnation

RUST (*Uromyces caryophyllinus* [Schrank] Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

YELLOWS (?). Serious on some varieties.

Carrot

LEAF BLIGHT (*Macrosporium carotae* E. & L.). Only one report but in that case very severe. Unverified reports indicate that the disease was prevalent and severe in other parts of the state.

Catalpa

LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common. Note: This leaf disease was accompanied by a falling of the leaves which many people supposed to be due to the disease. The spotting was no more severe this year than in previous years, and the falling was probably due in part to ather causes.

LEAF SPOT (*Cercospora catalpae* Wint.). Common.

Cedar

RUST (*Gymnosporangium juniperi-virginianae* Schw.) (*Gymonsporangium germinale* Schw. [Kern]). Reported, but of little importance. The former was most abundant in Cape May County.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Very abundant in certain localities. Most important celery disease in the state.

HEART ROT (Bacterial ?). Very severe in many localities.

STEM ROT (*Sclerotinia libertiana* Fckl.). Very severe in one locality.

Cherry

BROWN ROT (*Sclerotinia cinerea* [Pers.] Schr.). Common.

LEAF SPOT (*Cylindrosporium padi* Karst.). Common.

WINTER INJURY. Several complaints.

Chestnut

BARK DISEASE (*Endothia parasitica* [Mur.] Ander.). Common throughout the state.

LEAF SPOT (*Actinopelte japonica* and *Marssonia ochroleuca* B. & C.). Frequent.

Chrysanthemum

WILT (*Fusarium* sp. or *Verticillium* sp.). Common on certain varieties in greenhouses.

DODDER (*Cuscuta* sp.). In one greenhouse.

Corn

SMUT (*Ustilago zeae* [Beckm.] Ung.). This very common and widely distributed disease is not often serious except on sweet corn.

WILT (*Pseudomonas stewarti* Erw. Smith). Very few reports.

BLIGHT (*Bacterium* sp.). Common. (See page 525.)

RUST (*Puccinia sorghii* Schw.). Not serious.

LEAF BLOTCH (*Helminthosporium inconspicuum* E. & E.). Common. Farmers attribute this to weather.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Frequent.

Cranberry

SCALD (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the state, and the cause of considerable loss where the bogs were not well sprayed.

Cucumber

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. [Smith]). Very widely distributed and the cause of considerable loss.

DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common and frequently the cause of heavy losses.

LEAF SPOT (*Macrosporium cucumerinum* E. & E.). Frequent.

STEM ROT (*Sclerotinia libertiana* Fckl.). Occasional. Very destructive in one greenhouse.

Currants

CANE BLIGHT (*Botryosphaeria ribis* G. & D.). Frequent.

LEAF SPOT (*Septoria ribis*). Very common.

Dahlia

LEAF SPOT (*Phyllosticta* sp.). Common.

ROOT ROT (*Sporotrichum* sp.). One report.

Dewberry

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand-picking the diseased buds early in the season. It is most severe on Lucretias, Rathbuns and Black Diamonds.

ANTHRACNOSE (*Gloesporium venetum* Speg.). Very abundant and in some cases destructive.

LEAF SPOT (*Septoria rubi* West.). Common.

RUST (*Gymoconia peckiana* [Howe] Tranz.). Reported as common and in some cases destructive.

Eggplant

LEAF AND STEM BLIGHT AND FRUIT ROT (*Phomopsis vexans* [Sacc. & Syd.] Harter). Very common and in some cases destructive.

WILT (*Fusarium* sp.). Common and destructive.

Gladiolus

ROOT ROT (*Rhizoctonia* sp.). Occasional.

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). *Gloesporium* stage has been found in several places.

LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* [Ell.] Viala & Ravaz). Common and very destructive in many vineyards in the southern part of the state.

ANTHRACNOSE OR BIRD'S EYE ROT (*Gloesporium ampelophagum* Sacc.). Occasional.

RIPE ROT (*Gloesporium fructigenum* Berk.). Occasional.

NECROSIS (*Fusicoccum viticolum* Reddick). Occasional.

DOWNY MILDEW (*Plasmopara viticola* [B. & C.] D. T.). Common but not serious.

BITTER ROT (*Melanconium fuligineum* S. & V.). Occasional.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common and the subject of many inquiries.

Horse Chestnut

LEAF BLOTCH (*Phyllosticta paviae* Desm.). Less severe than usual.

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common.

Lilac

MILDEW *Microsphaera alni* [Wallr.] Wint.). Abundant throughout the state.

LEAF SPOT (*Phyllosticta halstedii* Ell.). Reported from several localities.

Maple

TAR SPOT (*Rhytisma acerinum* [P.] Fr.). Occasional.

LEAF SPOT (*Phyllosticta acericola* C. & E.). Common.

ANTHRACNOSE (*Gloesporium apocryptum* E. & E.). Several records.

LEAF SCALD (Physiological). Many complaints.

WINTER INJURY. Occasional.

Muskmelon

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Common and destructive in some cases.

DOWNY MILDEW (*Plasmopara cubensis* [B. & C.] Humphrey). Common but not severe.

MOLD (*Cladosporium cucumerinum* Ell. & Arth.). Common.

Oak

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kelb.). The *Gloeosporium* stage was sent in a few times.

MILDEW. Conidial stage.

Oats

SMUT (*Ustilago avenae* [Pers.] Jens.). Common.

RUST (*Puccinia coronata* Cda.). Common.

RUST (*Puccinia triticina* Eriks.). Common.

RUST (*Puccinia graminis* Pers.). Occasional.

Okra

WILT (*Verticillum* sp.). Abundant in one locality.

Onion

BULB ROT (*Botrytis* sp.). One report, not serious.

Pea

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

Peach

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the state. Severe on fruit in unsprayed orchards.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Common. See apple.

LEAF CURL (*Exoascus deformans* [Berk.] Fuckel). Abundant where the orchards were not sprayed.

SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of the spraying.

SHOT HOLE (*Phyllosticta circumscissa* Cooke). Common.

SHOT HOLE (*Bacterium pruni* Smith.) Common and in some cases very severe.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Occasional.

YELLOWS AND LITTLE PEACH. Much more severe than usual, frequently causing heavy losses in well kept orchards which previously were comparatively free from disease.

WINTER INJURY. Several reports.

Pear

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni.). Common. See apple.

LEAF BLIGHT (*Fabrea maculata* [Lev.]). *Entomosporium* stage. Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH (Cause undetermined). Abundant.

Peony

BUD ROT (*Botrytis* sp. ?). Prevalent.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in fall.

ROT (*Macrosporium* sp.). Common on fruits. May have been secondary.

MOSAIC (Cause undetermined). Very severe and the cause of heavy losses.

SUN-BURN. The fruits of the large fruited varieties are frequently sun-burned, making them very susceptible to rot injuries.

Pine

BLISTER RUST (*Cronartium ribicola* Fisch de Waldh.). This disease was found in one nursery.

Poplar

LEAF SPOT (*Marsonia populi* [Lib.] Sacc.). Common.

CANKER (*Dothichiza populae* S. & B.). Common and destructive wherever established.

Potato

SCURF (*Rhizoctonia* or *Corticium vagum* D. & C. var. *solani* Burt.). This is a very widely distributed disease, but was less severe than in previous years.

BLACK LEG (*Bacillus phytophthorus* Appel). This well known disease was less severe than usual.

SCAB (*Actinomyces chromogenus* Gast.). This disease was fully as severe as in past years.

EARLY BLIGHT (*Alternaria solani* [E. & M.] S. & G.). This disease was very abundant and very destructive immediately following the heavy rains about the middle of July. It was closely associated with tip burn.

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was not reported, but probably occurred in the mountainous districts.

TIP BURN. Very abundant and very destructive immediately following the heavy rains about the middle of July.

LEAF ROLL (Cause unknown). Less severe than usual.

CURLY DWARF (Cause unknown). Uncommon.

Phlox

POWDERY MILDEW (*Erysiphe communis* [Wahl.] Schl.). Common.

Privet

ANTHRACNOSE (*Gloesporium cingulatum* [Atk.] S. & S.). Occasional.

Plum

BLACK KNOT (*Plowrightia morbosa* [Schw.] Thüm.). Common throughout the state.

BROWN ROT (*Sclerotinia cinerea* [Bon.] Wor.). Common throughout the state.

SHOT HOLE (*Phyllosticta circumcissa*). Occasional.

LITTLE PLUM (Cause undetermined). Occasional.

Quince

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and very severe. See apple.

FIRE BLIGHT (*Bacillus amylovorus* [Burr.] De Toni). See apple.

RUST (*Rostellia aurentiana* Peck.). Occasional.

Raspberry

ANTHRACNOSE (*Gloesporium venetum* Speg.). Abundant and destructive.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Abundant. See apple.

LEAF SPOT (*Septoria rubi* West.). Abundant.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Very abundant and destructive. The cause of many complaints.

Rose

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Towns.). Frequent.

ANTHRACNOSE (*Gloeosporium rosae* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosae* [Lib.] Fr.). Common and very severe in the greenhouse.

POWDERY MILDEW (*Sphaerotheca pannosa* [Wallr.] Lev.). Common and very severe.

LEAF SPOT (*Phyllosticta rosicola* Massal.). Abundant and frequently confused with black spot.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common.

Snapdragon

ANTHRACNOSE (*Colletotrichum anthirrhini* Stew.). Occasional.

RUST (*Puccinia anthirrhini* D. & H.). Occasional.

STEM ROT (*Sclerotium*). One record. Very destructive.

Squash

MOSAIC (Cause undetermined). One record. A peculiar mottling of the leaves, characteristic of the disease on other plants. No insects present.

Strawberry

LEAF SPOT (*Mycosphaerella fragariae* [Tul.] Lindau.). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

LEAF SPOT (*Marsonia potentillae* [Desm.] Fisk). Frequent.

WINTER INJURY. Frequent.

Sunflower

RUST (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

BLACK ROT (*Sphaeronema fimbriatum* [E. & H.] Sacc.). Abundant and very severe.

WET ROT (*Rhizopus nigricans* Ehr.). Common in storage but readily controlled by ventilation.

STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen.). Common and very destructive.

ROT (*Trichoderma Koenigii* Oud.). Frequent.

CHARCOAL ROT (*Sclerotium bataticola* Taub.). Frequent.

ROT (*Trichoderma Koenigii* Oud.). Frequent.

ROT (*Penicillium* sp.). Common. May have been secondary.

SCURF OR SOIL STAIN (*Monilochaetes infuscans* E. & H.). Common.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* [Sacc. & Speg.] Kleb.). Very abundant.

Tomatoes

ANTHRACNOSE (*Colletotrichum phomoides* [Sacc.] Chester). A few reports.

FRUIT ROT (*Macrosporium solani* E. & M.). Abundant.

STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.

BLOSSOM END ROT (Cause questionable). Common.

LEAF SPOT (*Septoria lycopersici* Speg.). Abundant and very severe in some localities.

MOSAIC AND FILIFORM LEAF (Cause undetermined). Very common but much less severe than in 1915 and 1916.

LEAF SPOT (*Marsonia juglandis* [Lib.] Sacc.). Abundant.

YELLOWS (Cause undetermined). Two records.

Watermelon

ANTHRACNOSE (*Colletotrichum lagenarium* [Pase.] E. & H.). Abundant in the southern part of the state.

WILT (*Bacillus tracheiphilus* E. F. Smith). Common.

Wheat

RUST (*Puccinia coronata* Cda.). Common. (*Puccinia graminis* Pers.). Occasional. (*Puccinia rubigo-vera* deC. Wint.). Common. (*Puccinia triticina* Errh.). Common.

SMUT (*Tilletia foetens* [B. & C.] Trel.). Frequent. (*Tilletia tritica* [Bei.] Wint.). Abundant.

MOLD (*Cladosporium herbarum* [Pers.] Lk.). Abundant in places.

Willow

LEAF SPOT (*Gloeosporium salicis* West.). Common.

REPORT OF CELERY INVESTIGATION

R. F. POOLE

Experimental work started on the farms of Tunis Drenth and Drenth Bros. has been continued. Other investigations have been carried on at Gunlah's Farm, near Ridgewood. The principal diseases found this year were the same as reported in previous years. The past season has been very favorable for the spreading and the developing of bacteria and fungi. These have caused considerable loss in some parts of the bogs. The crown rot (*Bacterium* sp.), damping off or stem rot, (*Sclerotinia libertiana*), root knot caused by nematodes, the early blight (*Cercospora apii*), and the late blight (*Septoria petroselini,* var. *apii*), are the diseases of most concern to the farmers. Damping off caused by *Rhizoctonia* gave some trouble in one greenhouse this past spring.

In soil sterilization it was our purpose to rid the greenhouse beds and diseased areas in the field of the crown rot organism (*Bacterium* sp.). Some form of sterilization must be used to control damping off, caused by *Sclerotinia libertiana.* Acids, bases, and salts of different strengths have been applied to diseased areas in the field. Lime, hydrochloric acid, and copper sulfate have shown slight control. A more thorough trial must be given these compounds before any definite conclusion will be reached. Steam sterilization will, when thoroughly applied, control the organism. The irregularity of the diseased areas and the resistant plants, which grow in these diseased areas, greatly conflict with accurate control data. The crown rot organism has spread to practically every farm in the bogs of North Jersey. The best solution of the problem now seems to be plant breeding. In all diseased areas a small percentage of vigorous-growing, Golden Self-Blanching plants will be found to be immune to the crown rot organism. Seed from these resistant plants should produce a very high percentage of immune plants. Several farmers in this state grow their own celery seed each year. From work done on selecting disease-free cotton and cabbage, this appears to be an equally good chance for selection and, at the same time, teaches the farmer methods of breeding for higher plants.

During April several complaints of root knot were reported on celery. The knots, caused by nematodes, were formed several weeks after the soil was sterilized with formaldehyde. The

benches were decaying very badly and they were without a doubt the source of reinfection. The bench showing the most knots was divided into halves; one half was well stirred and treated with 6-50 formaldehyde. It was then covered with sacks for one week. The sacks were removed at the end of a week's time; the soil stirred and allowed to air for one week. Two weeks after the formaldehyde was put on, the seed was sown in both treated and untreated soil. The nematodes produced root knots in the untreated soil, as was the case in the first crop. The plants on the untreated soil showed no signs of root knot, and were vigorous-growing plants.

The *Sclerotinia libertiana,* damping off or stem rot, will soon be one of the celery growers' most troublesome pests. This is the same fungus that causes lettuce drop. It did a great deal of damage to beans in the bogs also. About twenty-five heads of lettuce with *Sclerotia* and growing mycelium were placed in a box 2x3 feet and mixed with soil. Celery seed was sown in the box, and after the plants were several inches high, they were kept in a warm, shady place and watered constantly. Almost all of the plants died as they had done in the greenhouses of North Jersey.

Celery, lettuce and beans are the farmers' chief crops in this section. Their continued growth on the same land makes it hard to select soil free from *Sclerotia* for the greenhouse beds. The matting together of the mycelium to form a hard *Sclerotia* which remains in the soil indefinitely, is difficult to penetrate and kill with formaldehyde unless conditions which are favorable to germination or decay are brought about. If the fungus is watched closely, the diseased spots can be removed before spreading. A light layer of sand on the surface will control the disease. The mycelium does very little, if any, damage below the surface of the soil. It spreads rapidly over the surface attacking the plants near or just above the ground. This disease is encouraged by crowding, not enough sunlight reaching the plant stem, and by overwatering.

After considerable damage to the plants, the beds were divided into four sections. Section I was thinned; the diseased plants were removed and sodium nitrate was broadcasted at the rate of 250 pounds per acre and washed into the soil. Section II was not

thinned, but nitrate of soda was applied as in Section I. Section III was thinned; the diseased plants were removed and no sodium nitrate was added. Section IV received no treatment. At the end of two weeks' time, the celery in Section I had made considerable growth, and very few plants were dying. Section II grew as well as Section I. However, the plants were very thick and most were dying. Section III had very few dead plants. They were very small and sickly. Only a very few plants remained in Section IV, and they had died early.

Several hundred plants were taken from Section I and set from 4 to 7 inches apart in the field. No diseased plants were found after transplanting.

The crown rot disease caused by *Bacterium* sp. has practically made the growing of Golden Self-Blanching celery unprofitable throughout the muck-soil districts.

In order to find a control for this disease, we have used carbolic acid, cresol, hydrochloric acid, copper acetate, lime, formaldehyde, sulfur, liver of sulfur, carbon bisulfide, potassium bisulfide, copper sulfate, ferrous sulfate, corrosive sublimate, potassium hydroxide, sodium chloride and calcium chloride. The liquids were diluted, and some poured into shallow holes, drenching the soil. The solids were either dissolved and applied in liquid form or applied in solid form by broadcasting and mixing with soil. The irregularity of the disease has made collecting control data very uncertain.

If Golden Self-Blanching plants are set into the field soon after all danger of being killed by frost is over, they seem to resist the disease. A large majority of the late plants die in a few weeks after they are set in the field. A few areas in the bogs this year grew the finest kind of first-crop celery; but the second crop was a complete failure on the same land. Soil removed from the greenhouse should never be placed on land free from crown rot. In a few instances this organism has been carried from upland by carting out soil from diseased areas. Crates shipped from one farm to another seem to be the source of spreading the organisms over the country. A quarantine should be placed on all old crates before another crop of celery is grown.

The results of the chemical project on Drenth Bros. farm are given in table 1. Sodium hydroxide, bleaching powder and carbon bisulfide were applied on April 13; and formaldehyde on May 8. All other compounds were applied on April 2. The sections are 20 feet

long and 15 feet wide. The plants were set in the field on June 15. During the growing season, four counts were made of the plants in each section at different times. The number of healthy, sick and dead plants in each case is given in the table. Plants were designated as healthy when found growing normally, and sick when showing lack of growth and a yellowing of the foliage. This table, while not showing any control, does give the death rate, and indicates that a few chemical compounds like hydrochloric acid (HCl) and lime ($CaCO_3$) show some prospects of control.

Table 1

Results of Experiment on Control of Celery Diseases

Sections	Compounds	Strengths	Plants 6-28	1st Count 7-10			2nd Count 7-25			3rd Count 8-7			4th Count 8-17		
				Healthy	Sick	Dead	Healthy	Sick	Dead	Healthy	Sick	Dead	Healthy	Sick	Dead
1	Hydrochloric acid	5	296	220	76	0	114	155	0	113	165	0	26	270	0
2	Sodium hydroxide	10	311	214	97	0	91	220	0	58	232	21	23	267	21
3	Bleaching powder	8	309	254	55	0	128	118	0	128	181	0	36	260	13
4	Potassium sulfide	2	297	185	112	0	37	226	34	19	122	156	16	47	234
5	Calcium carbonate	8 tons per acre	291	266	25	0	210	76	5	111	175	5	33	254	5
6	Copper sulfate	2 2-3	307	208	99	0	118	90	99	27	150	130	27	126	154
7	Carbon bisulfide	20	309	205	104	0	133	162	4	184	100	25	20	123	166
8	Check		295	116	179	0	21	201	73	21	53	221	15	39	241
9	Bichloride of mercury	1 1-3	296	123	173	0	20	185	91	15	114	165	19	66	221
10	Check		305	114	185	6	31	204	70	22	134	149	21	74	210
11	Sulfur	11 lbs.	305	101	202	2	19	196	90	21	102	182	24	22	259
12	Cresol	1 1-3	298	93	205	0	23	149	126	23	53	222	20	5	273
13	Zinc chloride	8 1-2 lbs.	288	116	172	0	57	224	7	21	155	112	21	91	176
14	Hydrochloric acid	9 pts.	304	218	86	0	98	204	2	30	272	2	30	266	8
15	Check		298	230	68	0	45	230	23	21	151	126	18	71	209
16	Formaldehyde	24 pts.	278	218	78	0	50	211	17	27	110	141	14	57	206

The early blight, *Cercospora apii,* appeared during the latter part of July. It spread rapidly to many areas by thrips and hoppers. It did considerable damage to second-crop celery. The late blight, *Septoria Petroselini apii,* was found about the middle of August. It did considerable damage to late celery. If spraying is started in the greenhouse when the plants are small and continued every ten days in the field with a thorough spray of 5-6-50 Bordeaux or with 10-50 Kil-Tone, the leaf spots will give no trouble.

The growers are fortunate in being able to grow all green varieties on the diseased lands. It is our purpose to develop a Golden Self-Blanching strain which will be immune to the crown rot organism, *Bacterium* sp., by breeding for disease-resistance. The problems are many, and they will require more study in the future.

TOMATO SPRAYING EXPERIMENTS AT RIVERTON, N. J.

WILLIAM H. MARTIN

During the summer of 1917 tomato spraying experiments for the control of late blight (*Septoria lycopersici* Speg.) were conducted on the Joseph Campbell Company farms at Riverton, N. J. The work was done by the department of plant pathology of the New Jersey Agricultural Experiment Station in cooperation with the Office of the Cotton, Truck and Forage Crop Disease Investigations of the United States Department of Agriculture and the Joseph Campbell Company. The writer wishes to express his thanks to Mr. H. F. Hall of the latter company and to Mr. G. Johnson, manager of the farm, for the many courtesies shown him during the progress of the work.

The experiment was designed to test out, under field conditions, sprays developed by Mr. F. J. Pritchard and Mr. W. Blair Clark of the Bureau of Plant Industry. At the same time an effort was made to determine some of the important facts in the life history of the organism causing late blight, and also to determine, if possible, how the disease is disseminated and how it lives over winter. This report will be limited to a brief discussion of the spraying experiments; a complete presentation of the other data will follow at a future date.

The late blight of tomatoes has been the cause of serious losses throughout New Jersey for a number of years. Ten years ago a 15-ton crop of tomatoes was by no means uncommon, this year it is doubtful if the average yield will exceed 4 tons. These figures are based on the statement of the growers. The tomato crop is well adapted to New Jersey conditions, but at the present cost of labor and fertilizers a 4-ton crop grown for the cannery will not yield a profit. A large part of this decrease in yield can be traced directly to the presence of leaf blight.

This is a comparatively new pest, not being recorded in the United States until 1893, and it is only in recent years that it has become severe. Thus far all efforts to breed resistant plants or to grow resistant varieties have failed and therefore spraying is the only method that has been found to combat the disease. In sections of New Jersey a number of growers have sprayed with the stan-

dard Bordeaux mixture for the control of late blight, and in some instances a partial control followed, but more frequently little differences resulted. In the work conducted by this department at Salem, N. J., in 1916 very little control was secured, although there was an increase in yield. This lack of success cannot be said to be due entirely to the spray, as it is a recognized fact that success in spraying is largely a question of methods, and also the time of application is an important factor. Last season the writer was unable to be in the field throughout the summer, so that it is possible that the applications were not made at the most opportune time. In 1917 the work was directed from a field laboratory so that a better opportunity was given to observe the progress of the disease. In this way the applications were not made at stated intervals, but when it was thought they would accomplish most good.

Spray Mixtures Used

The failure of the standard Bordeaux mixture to control the blight in the past indicated the advisability of using some other spray mixture or a modification of the standard Bordeaux mixture in its place. During the past season the following mixtures were employed.

1. Standard Bordeaux mixture in the proportion of 4 pounds of copper sulfate, 4 pounds of lime to 50 gallons of water. This was prepared according to common practice.

2. Standard Bordeaux mixture with resin fish-oil soap. This was prepared exactly as the preceding except for the addition of 3 pounds of soap to each 47 gallons of the 4-4-50 mixture. The soap was added to the mixture after it had been run into the spray tank, in order to eliminate the excessive formation of suds.

3. Bordeaux mixture with diminished lime, and resin fish-oil soap, 4-2-3-50. In this mixture the amount of lime used was one-half that of the copper sulfate. As in the preceding mixture the soap was added in the spray tank.

4. Deka-copper sulfate mixture with resin fish-oil soap 2-0.4-3-50. This mixture was made up according to Pickering's copper sulfate and lime water formula C[1] with the addition of 3 pounds of soap

[1]Eleventh Report, Woburn Experimental Fruit Farm, 1910.

to each 4 gallons of the mixture. It was prepared by stirring 4 gallons, containing 2 pounds of the copper sulfate solution, into 40 gallons of saturated lime water. This was then made up to 47 gallons and 3 gallons of soap solution, containing 3 pounds of soap added.

5. Copper-soap mixture, 0.5-0-3-50. This was prepared by diluting ½ gallon, containing ½ pound of copper sulfate solution, to 47 gallons and adding 3 gallons of the soap.

To facilitate the preparation of the sprays, stock solutions were made up. The milk of lime stock solution was made up at the rate of 1 pound of lime to 1 gallon of water, the copper sulfate, ½ pound to 1 gallon; and the soap, 1 pound to 1 gallon. No difficulty was experienced in getting the soap into solution, but hot water is necessary to dissolve it properly. After once in solution it will not settle out.

No trouble was experienced in mixing any of these sprays. When soap was added it was found best to do so after the mixture of the other ingredients had been run into the tank. If the soap is added in the mixing tank and then run into the spray tank, serious difficulties will be encountered. In some cases, where there was excessive agitation, an abundant formation of suds made trouble, but it was soon found that very little agitation was necessary to keep the mixtures in suspension, and after this no difficulties were experienced.

The advantages of the addition of soap were plainly seen. Not only did it increase the spreading qualities of the spray to a marked extent, but it also greatly increased its adhesiveness. Instances were noted where, after a heavy rain, the standard Bordeaux mixture was washed from the leaves, while the plants sprayed with the Bordeaux-soap mixtures were still white with the spray. It is also believed that the presence of the soap increases the fungicidal value of the spray.

Spraying Machinery

At the same time that sprays were tested out, an attempt was made to determine the method of applying the spray that would give best control. For this work two types of spray machinery were used. The first was a gasoline power sprayer furnished by the Office of Cotton, Truck, and Forage Crop Disease Investigations. This outfit

was a 2-horse 2-wheel cart with a 100-gallon tank. It was equipped with two lines of hose, each 25 feet long, one from each side of the machine. Each hose was equipped with a 5-foot iron extension rod, each rod being fitted with an angle nozzle. Five rows can be sprayed on each side of the machine, so that including the row driven over, 11 rows can be sprayed at one trip through the field. For the first several applications a pressure of 150 to 175 pounds to the square inch was maintained, for subsequent sprayings this was increased to 200 to 225 pounds. This pressure gave a very fine mist and the upper leaf surfaces were well covered. It was found practically impossible to cover the lower leaf surfaces completely. This was especially true when the plants had attained full growth; they fell to the ground and it was impossible to reach the lower surface of any but the uppermost leaves. Then again, the field in which the experiment was conducted became overgrown with weeds so that for the last applications it was impossible to spray the under leaf-surface.

The other machine used was a well known traction sprayer. With this machine a pressure of 150 to 175 pounds to the square inch was maintained. For the first applications there were only two nozzles to a row but this was found to be unsatisfactory and a third one was added. Three rows were sprayed at a time and the nozzles were so adjusted that a uniform film was distributed on the majority of the leaves. An attempt was made to adjust the side nozzles so as to reach the under leaf-surface, but this was found to be practically impossible, so only a part of the leaves received any spray on the under-surface. It will be shown later, however, that very satisfactory control was secured by both of these machines, and it would therefore appear that it was not absolutely necessary that the under leaf-surface be covered with a film of the mixture. No statements to this effect can be made at this time; it is hoped, however, that future work will throw some light on this point.

With the power sprayer the sprays were applied at the rate of 250 gallons to the acre. This thoroughly covered the upper leaf-surfaces. With the traction sprayer 175 gallons to the acre were applied. For the first application the plants were sprayed once, but as the covering obtained did not seem sufficient to give best results, for subsequent applications each plot was sprayed twice, once each way. In most instances this gave an ideal film. It was noticed that

too high pressure was not desirable for some of the sprays, especially with the copper-soap mixture. With a pressure of 150 pounds a uniform film could be secured, while with very high pressure the spray very often collected in drops. This can no doubt be explained by the presence of the soap, as it was not found to be true when the standard Bordeaux mixture was used.

Plan of the Experiments

As previously stated, the purpose of this work was to ascertain if the late blight could be controlled by spraying. Three sets of experiments were conducted. In the first, no attempt was made to limit the number of applications; they were made at approximately 10-day intervals throughout the season. In the second experiment the plots were sprayed two and three times, respectively, the first application being made sometime after the disease had made its appearance. This experiment was conducted to determine if the blight could be held in check after it had once made its appearance and also with the expectation that the results would be of aid in planning another season's work. The third experiment was with late tomatoes, the purpose of this experiment being also to determine, if possible, the effect on the ripening of the crop. Very frequently in New Jersey the late varieties are killed by frost before the crop is picked. It was thought that spraying might hold the leaves and further delay the ripening of the fruit. Should this happen the advisability of spraying late tomatoes is questionable. Each of these experiments will be discussed in turn.

Field Tests

The field in which this experiment was conducted was in tomatoes in 1914, okra in 1915 and tomatoes in 1916. After the 1916 crop was removed the field was put in rye; this was plowed under in the spring and fertilizer applied at the rate of 500 pounds to the acre before the plants were set out. The fertilizer was made up of 500 pounds of tankage, 400 pounds of nitrate of soda and 2000 pounds of acid phosphate. Shortly after the plants were established they were side-dressed with 300 pounds of fertilizer to the acre and again on July 7 with 350 pounds to the acre. For these two applications the mixture was made up of 1200 pounds of tankage, 400 pounds of nitrate of soda and 400 pounds of acid phosphate.

The plants were of the Bonney Best variety, an early tomato very much in favor in this part of the state. They were set out May 15, only thrifty plants being used. The rows were made 6 feet apart with the plants 3 feet apart in the row. This was done to permit the use of the power sprayer, the tread of the machine making it impossible to employ the 5-foot row customary in this state. The field as laid out contained 24 plots, each 6 rows wide, or approximately one-half acre. Between each six rows a driveway was provided for by the omission of a row. This was done to facilitate spraying and the taking of records. The employment of plots of this size eliminated to a large extent the extensive use of check plots otherwise necessary to minimize differences in yield resulting from soil variation. The need of check plots is recognized, but in this work where the check plots were employed largely to show differences resulting from spray treatment, their extensive use was hardly warranted.

Due to irregularities in the field the plots were not all the same size. In plots 23 and 24 a tree shaded some of the plants and these were discarded in getting yields. In computing the yield on an acre basis the yield per plant for each plot was determined and from this the yield per acre was obtained. As all missing plants were taken into consideration this method gives the most accurate measure of the actual yield per acre. In taking yields a count was made of the number of baskets from each plot; the yield in pounds per plot as then calculated from the average weight of 1000 baskets. This method was considered to be more convenient than and approximately as accurate as attempting to weigh all the baskets in the field.

The 24 plots were divided into 4 series of 6 plots each. In each series there were 5 sprayed plots and 1 unsprayed plot. Two of these, Series A and A-1, were sprayed with the power sprayer while the remaining two, Series B and B-1, were sprayed with the traction sprayer. This gave two instances of spraying with each type of spray machine, and four instances of spraying with each spray treatment. The four series were so arranged that the two methods of applying the spray alternated.

The purpose of this experiment being to determine if late blight could be controlled by spraying, no effort was made to limit the

number of applications, but as many were made as was thought necessary to control the disease. The present plan is to continue this work another season to determine how few applications are necessary to control the disease, as well as the most opportune time to make them. This season applications were made on the following dates: July 5, 12, 19, and 30, August 9, 17, and 27, making seven in all. It will be noticed that the first application was not made until the plants had become well established in the field. In the past, seed-bed spraying has been generally advocated. While this cannot be set aside from the results of one year's work, at least the results secured would tend to indicate that this application, as well as the very early applications in the field, can well be omitted. Late blight has been reported from other states as occurring in the seed-bed, but the writer has never observed it in this state. This year the disease was first observed on July 13. It was fruiting at the time, however, so that infection must have taken place about July 1. This first infection did not spread over the field, but this is no indication of what might happen another season. The general observations are that blight does not appear in this section of the state until about the middle of July; in the northern part of the state it frequently occurs two weeks earlier. Since the disease is present on the leaf some two weeks before it is evident to the eye, it might be well to make the first application about June 25, and a week or two earlier in the northern counties. It is frequently found necessary to spray for insects soon after the plants are set in the field, and again about two weeks later. For these two applications it would be well to use a combined insecticide and fungicide, which would take care of any early infections of late blight.

In table 1 is given the arrangement of the plots as they occurred in the field. This table also gives the yield per acre for ripe and green fruit, as well as the total yield per acre. From the table it will be seen that the yields of plots receiving the same treatment but in different parts of the experimental field vary considerably. This, no doubt, can be traced to soil differences, and in an experiment extending over so great an area this cannot be prevented. By the use of large plots, however, and repeating a treatment and its check four times, the differences resulting from the averages will give a fairly accurate measure of the benefit derived from the treat-

ment in question. It will be noticed, also, that the yield of green fruit is considerably greater from the sprayed plots than from the unsprayed. This may be accounted for by the fact that the sprayed vines remained vigorous for a longer period than the unsprayed. This green fruit was not wholly a loss, as it is common practice in New Jersey to pick and cover it when a frost is expected. In this way a greater part of the fruit is ripened, and therefore it well may be included in the total yields.

Table 2

Arrangement of Plots and Yield Per Acre of the Tomato Spraying Experiments Conducted at Riverton, N. J.

Treatment	YIELD PER ACRE		
	Ripe Fruit	Green Fruit	Total Yield
	Pounds	Pounds	Pounds
4-4-3-50	10,914	1381	12,295
4-2-3-50	9,897	864	10,761
4-4-50	12,608	1018	13,626
2-0.4-3-50	12,778	1638	14,416
0.5-0-3-50	12,463	609	13,072
Check	11,107	139	11,246
4-4-3-50	12,947	1011	13,958
4-2-3-50	12,391	1769	14,160
4-4-50	15,198	1327	16,525
2-0.4-3-50	15,464	2313	17,771
0.5-0-3-50	13,697	2313	16,010
Check	12,363	292	12,658
4-2-3-50	14,036	3630	17,666
4-4-3-50	14,036	3969	18,005
4-4-50	14,592	2787	17,379
0.5-0-3-50	15,560	1742	17,302
2-0.4-3-50	14,301	1255	15,556
Check	13,043	221	13,264
4-2-3-50	15,512	3242	18,754
4-4-3-50	15,415	1841	17,256
4-4-50	15,599	1473	17,072
0.5-0-3-50	13,939	1870	15,804
2-0.4-3-50	11,083	980	12,063
Check	9,784	166	9,950

Before discussing the yields from the different treatments, the control obtained by the use of the different mixtures will be considered.

Blight was first observed in this field on July 13. The disease had made very little progress from the point of initial infection, when a number of extremely hot days checked its advance. During this period the lower leaves of most of the plants in the field

were killed. An examination of the field on August 1 showed very little blight present, the infected leaves, for the most part, being killed during the hot weather. At about this time there was a week of wet weather and the disease again made its appearance. A careful survey of the field was made on August 13 and an estimate made of the number of leaves infected. Of the check plots two showed 50 per cent infection while the other two showed as much as 80 per cent. Several of the sprayed plots showed infection, but in these it was not more than 1 per cent. As the season advanced the sprayed plots showed considerably more infection, but the differences between them and the unsprayed plots were just as marked.

The last spray application was made August 27 and on September 7 an examination of all the plots was made to determine the per cent of dead leaves. This estimate was made to include all dead leaves, whether present on the plant or missing. It was impossible to do this for every plant, so every tenth plant in the middle row of each plot was taken.

Table 3 gives the per cent of dead leaves for each plot, as well as the average for each treatment.

Table 3

Per Cent of Dead Leaves on Each Plot and the Average for Each Treatment

Treatment	Per Cent of Dead Leaves				
	Series A	Series B	Series A-1	Series B-1	Average for each treatment
4-2-3-50	47	50	34	39	42
4-4-3-50	39	58	36	46	45
4-4-50	57	60	54	52	56
2-0.4-3-50	56	66	58	58	60
0.5-0-3-50	52	55	60	44	53
Check	95	94	96	96	95

To make these estimates a more accurate measure of the actual condition of the plants, separate readings were made on the same day by the writer and Mr. D. H. Davenport, the field assistant, and the percentages given in the table represent an average of these two readings.

At the time these observations were made and for several weeks previous, the unsprayed plants were stripped almost bare of any

leaves, only a few remaining at the tips of the branches. The stems also were heavily infested with the blight. On the date of the observations, the average number of dead leaves for the check plots was found to be 95 per cent, while for the poorest spray plot it was 60 per cent. The Bordeaux-soap plots gave the best control, with the 4-2-3-50 mixture, only 42 per cent of the leaves being dead. While there was a difference of only 18 per cent between the number of dead leaves on the best and that on the poorest sprayed plots, throughout the season the plots sprayed with the 4-2-3-50 mixture were uniformly better than the plots receiving the other treatments. Likewise, the plots sprayed with the Pickering mixture were poorer, throughout the season, than any of the others. The plots sprayed with the copper-soap mixture looked slightly better than those sprayed with the standard Bordeaux mixture, though neither was as good as the Bordeaux-soap plots.

Not all the leaves missing from a plant were lost through disease for, as has been previously stated, a number were lost during the hot weather in July. It is recognized that this is true for both the sprayed and the unsprayed plants, but the difference between the different treatments and between the sprayed and unsprayed plots was more pronounced than is indicated in the table. The photographs appended to this report will tend to illustrate this point more clearly (plate 6, fig. 1 and 2).

The fruit on the unsprayed plants was exposed to the sun and the greater part of the fruit set, ripened. On the sprayed plants the fruit was protected by the leaves until later in the season, no doubt accounting for the large amount of green fruit on these plots at the end of the season. In this connection it might be well to state that the fruit from the sprayed plants was of a much better quality than that from similar unsprayed plants. When a vine is stripped of all its leaves the ripening process is largely artificial, and as a consequence the fruit is of a poorer quality both as to color and flavor.

In table 4 the per cent of dead leaves, the average weight of green and ripe fruit per acre and the total yield per acre for each treatment are given. In the last column of the table is given for each treatment the increase in pounds of green and ripe fruit over the checks.

In this table the treatments are arranged in the order in which they controlled the blight. It will be seen that the treatment having the least dead leaves on September 7 gave the greatest amount of green fruit at the end of the season, and, disregarding the 2-0.4-3-50 mixture, the treatments with the greatest number of dead leaves gave the largest yield of ripe fruit. On the plots sprayed with the 4-4-50 mixture 60 per cent of the leaves were dead, while on the plots showing the best control only 42 per cent of the leaves were dead. On a basis of ripe fruit the 4-4-50 treatment out-yielded the other by 1738 pounds, while in green fruit the 4-2-3-50 treatment out-yielded the 4-4-50 by 725 pounds.

Table 4

Per Cent of Dead Leaves with Yield Per Acre for Each Treatment

Summary

Treatment	Per cent of dead leaves. Average of four plots	Green fruit pounds per acre. Average of four plots	Ripe fruit pounds per acre. Average of four plots	Total yield pounds per acre. Average of four plots	Increase over check; green and ripe fruit
4-2-3-50	42	2376	12,959	15,335	3554
4-4-3-50	45	2050	13,328	15,379	3598
0.5-0-3-50	53	1634	13,915	15,548	3767
4-4-50	56	1651	14,697	16,348	4567
2-0.4-3-50	60	1546	13,406	14,052	3171
Check	95	204	11,577	11,781	....

These results would tend to indicate that it is not desirable to hold all the leaves until the end of the season if all the fruit is to be ripened. In this state very little, if any, of the fruit set after September 1 will mature, and the energies of the vine should then be turned to ripening that which is relatively mature. While no definite statement can be made from the data at hand it would appear advisable to hold all the leaves possible until about the first of September, and after that only enough to protect the fruit.

While the 4-4-50 mixture did not give best control it gave the greatest increase in yield, 38 per cent over the check. The copper-soap mixture gave the next highest increase, though the difference in the yields from these plots and the Bordeaux-soap plots was only 1 per

cent, the former giving a 31 per cent increase over the check, while the latter gave a 30 per cent increase. The 2-0.4-3-50 treatment gave the poorest control, and at the same time the lowest increase, 26 per cent over the check plots. The nature of this spray makes its adoption impossible on an economic scale, so that it need not be discussed further. Eliminating this treatment there was a difference of only 8 per cent between the highest and lowest increases over the check plots.

These differences are based on the total yield. On the basis of ripe fruit the 4-4-50 treatment showed an increase of 27 per cent over the check plots, the 0.5-0-3-50 treatment 19 per cent, the 4-4-3-50, 15 per cent and the 4-2-3-50, 11 per cent. Here again is brought out the relation of the per cent of leaves held late in the season to the amount of fruit ripened. There is a variation of 16 per cent between the best and poorest treatments on the basis of ripe fruit, as compared with a difference of 8 per cent where total yield is considered.

While the copper-soap mixture did not give the best control, it is without doubt the most desirable of any of the mixtures used. Since it requires only ½ pound of copper sulfate and 3 pounds of soap to each 50 gallons of water, its use would mean a decided saving in the cost of materials over the old 4-4-50 mixture. The ease with which it is prepared and the fact that no lime is required are other factors very much in its favor. While it cannot be recommended from the results of one season's work to take the place of Bordeaux mixture, it is certainly worthy of future trial, and, should it prove as satisfactory as it has this year, there is little doubt that it will take the place of Bordeaux mixture for tomato spraying.

The Bordeaux-soap mixtures gave best control of the blight. This was even more noticeable than is indicated in the table showing the per cent of dead leaves. During the entire season the plots treated with these mixtures, and especially with the 4-2-3-50 mixture, stood out above all the others in vigor of the vines. There was little difference in yield between these and those treated with copper-soap mixture, however, so that what little difference there was in the control of the blight is amply made up for by the many advantages of the latter mixture.

Use of Traction and Power Sprayers

As has been stated, two of the four series, A and A-1 were sprayed with a power sprayer, while the other two, B and B-1, were sprayed with a traction sprayer. Several times during the summer trouble was experienced with the power sprayer at times when it appeared necessary that applications be made at once. Owing to these difficulties only four applications were made with the power sprayer, and the other three with the traction sprayer. Since this is true no definite conclusions can be drawn from the data at hand.

Table 5 gives the per cent of dead leaves in the different series, with the average for the two methods.

Table 5

Per Cent of Dead Leaves on Plots Sprayed With Traction and With Power Sprayer

Treatment	Per Cent of Dead Leaves					
	Power Sprayer			Traction Sprayer		
	Series A	Series A-1	Average	Series B	Series B-1	Average
4-2-3-50	47	34	40	50	39	44
4-4-3-50	39	36	37	58	46	52
4-4-50	57	54	55	60	52	56
2-0.4-3-50	56	58	57	66	58	67
0.5-0-3-50	52	60	56	55	44	49

From the table it will be seen that with four of the sprays the use of the power sprayer gave the better control. In one case, that of the 4-4-50 mixture, the difference is only 1 per cent, while it is 15 per cent in the case of the 4-2-3-50 mixture. With the copper-soap mixture the plots sprayed with the traction sprayer showed 7 per cent less dead leaves than those sprayed with the power sprayer. This may be due to the fact that the copper-soap mixture gives best results when applied at a lower pressure than was the case when the power sprayer was used. The data at hand will not warrant any conclusions of this kind, however.

While the differences are by no means great, there seems to be a tendency toward more complete control following the use of the power sprayer. In the use of this machine an effort was made to

spray the under leaf-surface, but only slight success was obtained, so any differences in favor of this machine over the traction sprayer are thought to be due more to the fact that the upper leaf-surfaces received a better covering.

In table 6 is given the total yield per acre of the plots sprayed with the power and traction sprayers, as well as the average for each.

Table 6

Yield Per Acre on the Plots Sprayed with the Traction Sprayer and with the Power Sprayer

Treatment	Yield Per Acre					
	Power Sprayer			Traction Sprayer		
	Series A	Series A-1	Average	Series B	Series B-1	Average
	pounds	pounds	pounds	pounds	pounds	pounds
4-2-3-50	10,761	17,666	14,213	14,160	13,754	16,457
4-4-3-50	12,295	18,015	15,416	13,958	17,256	15,605
4-4-50	13,626	17,379	15,502	16,525	17,072	16,798
2-0.4-3-50	14,416	15,556	14,986	17,771	12,063	14,917
0.5-0-3-50	13,072	17,302	15,187	16,010	15,809	15,909

It will be seen that in every case but one the differences are in favor of the traction sprayer. With Bordeaux mixture this difference is as much as 1296 pounds. A study of the table, however, will show that the normal variation in yield between Series A and Series A-1 and between Series B and Series B-1, is greater than the differences between the averages. The varying factor in this case would appear to be the soil rather than the method of applying the spray. Since this is true no conclusions can be drawn with regard to the relative merits of the two methods.

In view of the fact that the traction sprayer appears to have given as good results as the power sprayer, there is little to warrant the adoption of the latter machine. The cost of upkeep and running the power sprayer is much greater than the traction sprayer, and these factors should favor the use of the latter type of machine.

Summary

1. Late blight of tomatoes caused by *Septoria lycopersici* Speg. can be controlled by thorough spraying.

2. The sprays employed were found to control the late blight in the following order: (1) 4-2-3-50; (2) 4-4-3-50; (3) 0.5-0-3-50; (4) 4-4-50; (5) 2-0.4-3-50.

3. The sprays employed gave increased yields over check plots in the following order: (1) 4-4-50; (2) 0.5-0-3-50; (3) 4-2-3-50; (4) 4-4-3-50; (5) 4-2-3-50.

4. The standard Bordeaux mixture, while not giving the best control, gave the greatest increase over the check plots; indicating, possibly, that failure in its use in the past was a question of methods rather than the fault of the spray mixture.

5. The use of the copper-soap mixture (0.5-0-3-50) gave good results. Because of its low cost and ease of preparation it should be given serious consideration.

6. The Bordeaux-soap mixtures (4-2-3-50 and 4-4-50) gave good control but in other respects they are not as good as the copper-soap mixture.

7. The results of this season's work would indicate that it is not necessary to spray plants in the seed-bed in New Jersey.

8. In this state the first application should be made not later than July 1.

9. From the work conducted this season it would appear that if all the leaves are held until frost a large part of the fruit formed will not ripen.

10. Little difference resulted from the use of the two types of spray machines; the traction sprayer, due to its lower cost of upkeep, would appear to be the better.

Effect of Late Applications

The field in which this experiment was conducted received the same treatment as the first experimental field, with the exception that the plants were set out one week earlier. This land had been in tomatoes for 4 years, and during that time the blight had been very severe.

On July 18 most of the lower leaves of the plants in this field were infected with the blight. It was then decided to spray to de-

termine if the disease could be held in check by a few applications. Only two of the mixtures were used, the 4-4-3-50 and the 0.5-0-3-50, respectively. Since the first application was not made until July 21 their efficiency in controlling the blight was put to a severe test. The sprays were applied with a traction sprayer at 150 pounds pressure, at the rate of 175 gallons to the acre. As in the previous experiment the plants were sprayed once each way for each application.

The plots as laid out were approximately 1/7 acre in size, each plot was 3 rows wide and so arranged that each treated plot was adjacent to an untreated plot. Table 7 gives the arrangement of the plots. In the field they were not divided into two sections, as in the table, but were continuous. Plots 11, and 13 and 15 were sprayed July 21 and 31, while the remaining treated plots received a third application August 11.

Table 7

Arrangement of Plots and Yield per Acre from each Treatment

No.	Treatment	Yield per acre	No.	Treatment	Yield per acre
		pounds			pounds
1	Check	11,848	9	0.5-0-3-50	11,623
2	4-4-3-50	13,391	10	Check	11,275
3	0.5-0-3-50	11,848	11	0.5-0-3-50	11,848
4	Check	9,356	12	Check	12,271
5	4-4-3-50	12,719	13	0.5-0-3-50	13,359
6	0.5-0-3-50	14,909	14	Check	13,391
7	Check	10,952	15	0.5-0-3-50	13,814
8	4-4-3-50	11,176	16	Check	11,410

On August 24 a thorough examination was made of these plots. The plots sprayed three times were almost free from any infection, while the check plots were heavily infected, nearly every leaf showing spots. On the plot sprayed twice there was considerable infection, but these plots were decidedly better than their adjoining checks.

On September 5 another observation was made. At this time the plots sprayed twice were little better than their adjoining checks. This is to be expected since the last application of spray had been made July 31 and had without doubt been washed from the plants long before this, leaving them unprotected. The plots

sprayed three times were still better than the adjoining checks. The leaves were all diseased but were still green, while on the unsprayed plants only a few leaves remained at the apex of the branches.

In table 8 is given the average yield per acre for the plots receiving the two applications of spray as well as for their adjoining checks.

Table 8

Effect of Two Applications of Spray

Treatment	Pounds per acre	Difference
0.5-0-3-50	13,007	920
Check	12,087	....

Two applications of the copper-soap mixture gave an increase of 920 pounds over the adjoining checks. It is true that there is a large normal variation between the check plots, but inasmuch as the treatment and its check were repeated three times, the differences resulting from the averages may be attributed in part to the varying factor, which in this case is the two applications of spray.

In table 9 is given the average yield of the plots sprayed three times with that of their adjoining checks.

Table 9

Effect of Three Applications of Spray

Treatment	Pounds per acre	Difference
4-4-3-50	12,428	1,543
Check	10,885	....
0.5-0-3-50	12,800	2,106
Check	10,694	....

As in the first experiment the plots sprayed with the copper-soap mixture gave a greater increase over the checks than did the Bordeaux-soap mixture, being 19 per cent and 14 per cent, respectively. While the Bordeaux-soap gave slightly better control in the first experiment, in this one little difference was observed between the two treatments.

The results of this experiment would tend to show that late blight can be held in check after it appears in a field and also would indicate that early applications are not essential. The necessity of late applications is shown conclusively. The plots sprayed twice were killed some time before those sprayed three times. There is no reason to doubt that, had a fourth application been made, the plants would have remained green for several weeks longer.

The results of this and the first experiment indicate beyond a doubt, that late blight of tomatoes can be controlled by spraying, but the results also emphasize the importance of spraying at the right time. From our present knowledge, in order that the grower may be sure of spraying at the proper time, the applications should be spread over a long period of time; in other words, the vines should be kept covered. Where this is done success should follow.

Summary

The results of the above experiment may be summarized as follows:

1. The copper-soap and Bordeaux-soap mixtures will hold late blight in check even after it has appeared in the field.
2. The copper-soap mixtures appeared to control the blight as well as the Bordeaux-soap mixture.
3. The plots sprayed with the copper-soap mixture showed the largest increase over the unsprayed plots.
4. Early applications do not appear to be essential in the control of the late blight.
5. Two applications held the disease in check, while the third gave much better results, indicating that the late applications are of great importance.
6. The results emphasize the importance of spraying at the proper time, a few applications made indiscriminately cannot be expected to give results.

Effect of Spraying Late Tomatoes

This experiment was designed to determine the effect spraying would have upon late tomatoes. The soil in this field is much heavier than that in the other two. No manure has been applied to this land for the past four years; before the plants were set out 600

pounds to the acre of the following mixture was added: 1400 pounds of phosphoric acid, 200 pounds of nitrate of soda and 400 pounds of tankage.

The plots were laid out as in the preceding experiment and the following spray mixtures were used; 4-2-3-50; 0.5-0-3-50; 2-0.4-3-50; and 0-0-3-50. The latter was made up of resin fish-oil soap at the rate of 3 pounds to 50 gallons of water. This was used to determine if the soap had any fungicidal value when used alone. Applications were made on the following dates: July 31, August 13, August 19, August 28, September 3 and September 11, making 6 applications in all.

In table 10 is given the arrangement of the plots together with the yield in ripe and green fruit, as well as the total yield per acre.

Table 10

Arrangement of Plots and Yield Per Acre

Treatment	Ripe fruit per acre	Green fruit per acre	Total yield
	pounds	pounds	pounds
Check	10,955	2,112	13,067
4-2-3-50	11,203	4,225	15,428
0.5-0-3-50	9,648	3,703	13,351
Check	9,365	2,896	12,261
0-0-3-50	8,581	3,158	11,739
2-0.4-3-50	8,712	5,009	13,721
Check	7,252	2,635	9,887
4-2-3-50	8,538	5,009	13,547
0.5-0-3-50	8,276	3,158	11,434
Check	10,019	2,374	12,393
0-0-3-50	10,539	2,896	13,435
2-0.4-3-50	10,628	3,419	14,047
Check	10,345	1,847	12,192
4-2-3-5	11,086	3,158	14,244
0.5-0-3-50	10,409	2,374	12,784
Check	11,674	1,187	12,861
0-0-3-50	11,042	1,847	12,889
2-0.4-3-50	10,498	1,847	12,345
Check	10,606	1,317	11,923

Late blight did not appear in this field until September 5, and in the week following it became more prevalent though it never became very severe. This appeared to be true on all the fields; after the first week of September the disease made very little progress. On October 21 careful observations were made to determine the per cent of dead leaves in each plot, following the plan outlined in the first experiment.

Table 11 gives the per cent of dead leaves for each plot, as well as the average for each treatment.

At the time of this observation the unsprayed plants were still in fairly good condition. The leaves remaining on the plants showed very little infection and were of a good green color.

Table 11

Per Cent of Dead Leaves in Each Plot and Average for Each Treatment

Treatment	Series 1	Series 2	Series 3	Average
4-2-3-50	33	41	53	42
0.5-0-3-50	40	53	61	51
2-0.4-3-50	45	62	57	54
0-0-3-50	59	62	64	62
Check	67	73	85	75

The plots sprayed with the 4-2-3-50 mixture were slightly better than those sprayed with the copper-soap; the difference was not marked, however. The plots treated with the soap solution were better than the untreated, as there were 13 per cent less dead leaves on the former than on the latter. This would indicate that the soap alone had some fungicidal value.

Table 12

Ripe and Green Fruit and Total Yields Per Acre Average of Three Plots

Treatment	Ripe fruit per acre	Green fruit per acre	Total yield	Difference
	pounds	pounds	pounds	pounds
Check	9,517	2,198	11,715	....
4-2-3-50	10,275	4,130	14,405	2,690
0.5-0-3-50	9,445	3,078	12,523	19
Check	10,352	2,152	12,504	....
0-0-3-50	10,054	2,634	12,688	184
2-0.4-3-50	9,946	3,425	13,371	2,037
Check	9,401	1,933	11,334	....

Table 12 gives the average yields of the different treatments and of their adjoining checks.

The data in table 11 would indicate that the Pickering mixture has given as good results as the Bordeaux-soap mixture. Both of

these treatments gave an increase of 1 ton to the acre over their adjoining checks. The copper-soap mixture and the soap solution gave slight increases, but these are well within the experimental error, and no indicative results can be attributed to these two sprays. These slight differences may be explained by the fact that there was comparatively little disease in this field. Why two of the mixtures should give increased yields and the other two no increase, is rather difficult to explain in the light of the results of the first two experiments where the copper-soap mixture out-yielded the Bordeaux-soap mixtures.

The results secured would indicate that in this particular case it did not pay to spray. This variety of tomato is very late in ripening its fruit and where the the greater part of the leaves have been held until frost the ripening process is still further delayed. In this experiment the average amount of green fruit picked from the sprayed plots was 85 per cent more than from the unsprayed plots. However, no statement to the effect that it does not pay to spray late tomatoes can be made. In a field adjoining this, when the tomatoes were of the same variety but the plants were set out a week earlier, the plants were killed early in the season. In this case there is no doubt that spraying would have paid. Just why this difference should exist in the amount of disease present in the two fields is difficult to state. The field in which the experiment was conducted was high and well drained, while the other was low and comparatively wet, so there may be some relation between soil moisture content and appearance of the disease. Several other instances were noted during the summer where the disease first made its appearance in the lower portions of a field.

The results of this experiment would tend to indicate the impossibility of making any fixed dates for spraying The appearance of the disease seems to be largely determined by local conditions and results will be secured only through the efforts of the individual grower to make applications at the proper time.

Summary

1. In this experiment the different spray mixtures controlled the late blight in the following order: (1) 4-2-3-50; (2) 0.5-0-3-50; (3) 2-0.4-3-50; (4) 0-1-3-50.

2. Resin fish-oil soap gave partial control, indicating that it possesses some fungicidal value when used alone.

3. The results obtained from the experiment emphasize the fact that conclusions cannot be drawn from the results of one season's work.

4. Under certain conditions, in view of the results from this experiment, the advisability of spraying late tomatoes is questionable.

POTATO SPRAYING EXPERIMENTS IN 1917

MEL. T. COOK

During 1917 the department conducted potato spraying experiments in cooperation with Mr. T. M. Applegate, of Dayton, N. J. and with Mr. J. Harry Kandle of Elmer, N. J.

The work with Mr. Applegate was in cooperation with Mr. I. L. Owen, farm demonstrator for Middlesex County. In both cases the actual work was done by the growers according to plans furnished by the writer. The Kil-Tone and arsenate of lead were furnished by the Kil-Tone Manufacturing Company.

The test on Mr. Applegate's farm was made on early Cobblers. He sprayed this crop three times, using a combination of Bordeaux and arsenate of lead on 6 plots and arsenate of lead on the alternating 6 plots. The plots were 0.116 acre in size. The results when reduced to an acre basis are given in table 14.

Table 14

Yield of Potatoes Per Acre on Test Plots on Farm of T. M. Applegate, Dayton, N. J.

Treatment	Bushels per Acre
Bordeaux and lead	183.475
Arsenate of lead	168.535
Bordeaux and Lead	153.730
Arsenate of lead	173.560
Bordeaux and lead	178.445
Arsenate of lead	183.475
Bordeaux and lead	203.535
Arsenate of lead	208.189
Bordeaux and lead	183.475
Arsenate of lead	168.535
Bordeaux and lead	168.535
Arsenate of lead	148.705

It will be noted that the highest yield was 208 bushels on the arsenate of lead plot, and that the lowest yield was 148 bushels, also on an arsenate of lead plot. The average yield of the Bordeaux and lead plots was 178.532 bushels, as compared with an average yield of 175.166 bushels on the arsenate of lead plots, a difference of less than 3½ bushels per acre.

Two tests were made on Mr. Kandle's farm, one with a crop of early Cobblers and the other with a crop of late Cobblers (i. e. second-crop). The early Cobblers were sprayed twice, using Bordeaux and lead, Kil-Tone, and arsenate of lead. The plots were 3/10 acre in size and the results reduced to an acre basis are given in table 15.

Table 15

Yield of Early Cobblers Per Acre on Test Plots on Farm of J. Harry Kandle, Elmer, N. J.

Treatment	Bushels per Acre
Bordeaux and lead	300.000
Kil-Tone	316.662
Arsenate of lead	297.912
Bordeaux and lead	289.062
Kil-Tone	328.125
Arsenate of lead	323.125
Bordeaux and lead	314.582
Kil-Tone	306.250
Arsenate of lead	311.458
Bordeaux and lead	316,666
Kil-Tone	320.833
Arsenate of lead	317.083
Bordeaux and lead	325.000
Kil-Tone	309.375
Arsenate of lead	317.083

An examination of the results of this test shows the highest yield was 328 bushels on a Kil-Tone plot, and that the lowest yield was 289 bushels on a Bordeaux and lead plot. The average, in order of highest yield, was Kil-Tone 316.249 bushels; arsenate of lead 313.332 bushels and Bordeaux and arsenate of lead 309.062 bushels.

The late crop of Cobblers was sprayed twice with Bordeaux plus arsenate of lead and with Kil-Tone. As there were not enough potato bugs to injure the crop, it was decided to leave 4 plots with-

out treatment of any kind. The plots were one-third of an acre in size[2] and the results reduced to an acre basis are given in table 16.

These results show that the highest yield was 249 bushels on a Kil-Tone plot, and that the lowest yield was 195 bushels on an *untreated* plot. The average, in order of highest yield, was Kil-Tone 224.062 bushels, Bordeaux and lead 217.500 bushels, and untreated 210.469 bushels.

I doubt if much weight should be attached to these figures. In the early part of the season the potato crop was exceptionally free from diseases and the growth unsually good. In July heavy rains and warm weather brought on a most severe outbreak of tip burn fol-

Table 16

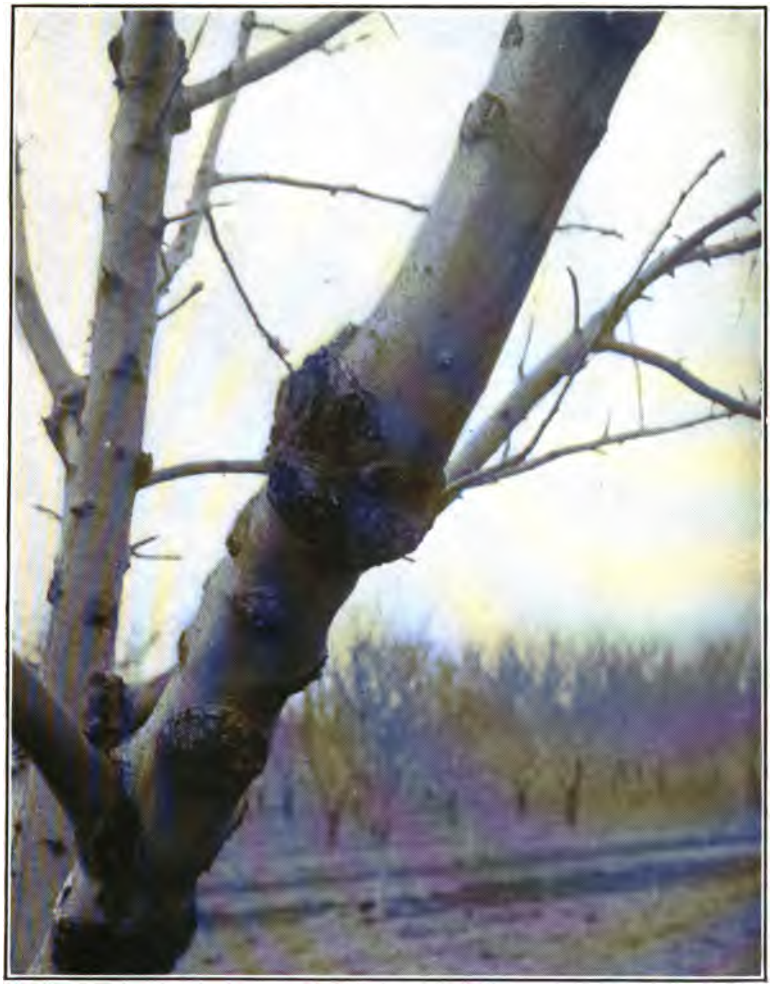
Yield of Late Cobblers Per Acre on Test Plots on Farm of J. Harry Kandle, Elmer, N. J.

Treatment	Bushels per Acre
Bordeaux and lead	204.375
Kil-Tone	349.375
Untreated	215.625
Bordeaux and lead	215.625
Kil-Tone	221.250
Untreated	210.000
Bordeaux and lead	225.000
Kil-Tone	215.625
Untreated	221.250
Bordeaux and lead	225.000
Kil-Tone	210.000
Untreated	195.000

lowed by a severe outbreak of early blight. The exceptionally healthy condition of the crop in the early part of the season would necessarily result in slight differences in treatments; the luxuriant growth interfered with the treatments, the July rains washed the spray mixtures off and the tip burn stopped further treatment.

[2]The plots were just twice as large as indicated, but only the central half of each plot was used in tabulating the results.

PLATE I



Aerial form of crown gall on branches of the apple.
(Photo by C. H. Connors.)

PLATE II

Greenhouse chrysanthemum attacked by common dodder.
(Photo by R. F. Poole.)

PLATE III

Poplar Canker (Dothichiza populæ).
(Photo by R. F. Poole.)

PLATE IV

Hail-stone injury on gooseberries.
(Photo by R. F. Poole.)

PLATE *V*

Hail-stone injuries on tomatoes and apples.
(Photo by R. F. Poole.)

PLATE VI

FIG. 1. Tomato spraying experiment: Plot 18 (Check).

FIG. 2. Tomato spraying experiment: Plot 19 (4-2-3-50).

JUL 28 1923

REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING

June 30, 1918

FROM
MEL. T. COOK
AGRI. EXP. STATION
NEW BRUNSWICK, N. J.

Union Hill, N. J.
HUDSON PRINTING COMPANY
1919

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

*WILLIAM H. MARTIN, A.B., *Research Assistant.*

†ROBERT F. POOLE, B.SC., *Research Assistant.*

*Resigned January 15, 1918, to enter military service.
†Resigned November 15, 1917, to enter military srevice.

CONTENTS

ORGANIZATION 299
1918 WORK 299
RESEARCHES 300
SEED BED DISEASES 300
DISEASE—RESISTANT PLANTS 301
NEEDS 301
THE HERBARIUM 302
PUBLICATIONS 302
LIST OF PLANT DISEASES 302
PLANT DISEASE SURVEY 302

Report of the Department of Plant Pathology

M. T. Cook

ORGANIZATION

The organization has been very much changed since our last report. Mr. C. M. Haenseler, who held the New Jersey Zinc Company fellowship, was called to the colors in September and is now in France with a regiment of Forestry Engineers. Mr. R. F. Poole, who came to us from Clemson College, S. C., May 1, 1917, as fellow and assistant, enlisted in November and is in France as photographer in the Aviation Corps; Mr. W. H. Martin, fellow and assistant, completed his work for the Ph. D. degree in January and enlisted in the Aviation Corps; Mr. F. P. Schlatter, who was doing minor work in the department, is in the photographic division of the Aviation Corps; Mr. C. A. Schwarze, State Nursery Inspector, resigned June 1, 1918.

This left the department without help, but fortunately the Office of Cotton, Truck and Forage Crop Disease Investigations, of the United States Department of Agriculture, assigned Dr. L. M. Massey to us for extension work in plant pathology. He had his undergraduate training at Wabash College, from which he was graduated in 1912, and took his Ph. D. degree at Cornell in 1916. Mr. Erdman West has been employed by the State Department of Agriculture as assistant nursery inspector, beginning work June 1, and is stationed here. He was graduated from the Pennsylvania State College in 1917.

1918 WORK

Because of war conditions we are planning to do less research than usual and to give more time to the immedate needs for food production. Dr. Massey will give special attention to tomatoes, peppers and sweet potatoes, but will respond to calls for advice and assistance in the control of plant diseases in general throughout the season. The demands for his time are already greater than can be met

RESEARCHES

1. The research work on fungi injurious to paint must necessarily be discontinued for the present. The future for this work was very promising at the time Mr. Haenseler was called away.

2. The research on the disease of celery must also be dropped for the present. This is a very promising line of work and should be continued as soon as possible. The work to date demonstrates (a) that seed-bed treatment is very important and profitable, (b) that crop rotation is advantageous, (c) that we should have more data covering soil treatments with fertilizers and other chemicals in the field, and (d) that spraying is profitable when well done.

3. The tomato spraying work will be continued on the farm of the Campbell Soup Company at Riverton, N. J., by the Office of Cotton, Truck and Forage Crop Disease Investigations of the United States Department of Agriculture; this office cooperating.

4. The studies on the transmission of potato diseases through seed tubers is being continued on the College Farm.

5. The potato spraying work also is being continued.

6. Because of the number of complaints in 1917 concerning a bacterial corn disease, we will make tests in cooperation with Prof. bacterial corn disease, we will make tests in cooperation with Dr. G. N. Hoffer, of the Indian Agricultural Experimental Station, who has been studying this problem for some time.

SEED-BED DISEASES

During the spring of 1918 we had more complaints than usual concerning *damping-off* in seed-beds. Losses of this kind cannot be estimated with accuracy but were no doubt much greater than is generally supposed even by those who are familiar with the facts. They undoubtedly resulted in delays in planting and reduced acreage of certain crops.

There are several organisms which cause *damping-off* in the seed-bed and some of them continue to thrive and cause losses in the field. This is especially true of *Sclerotinia Libertiana* which attacks lettuce, celery, beans, cucumbers and many other plants.

These troubles can be controlled very readily and at a very slight expense. It is one of the most profitable propositions for the vegetable grower. Unfortunately, the loss of men during the year made it impossible for us to take up this work. It should be taken up as an extension project before the time for making seed-beds for another year.

DISEASE-RESISTANT PLANTS

There is an increasing amount of evidence to show that certain types of plants can be controlled to the best advantage by the development of resistant strains or varieties. This is especially true of those disease, in which the casual organism works within the host and therefore cannot be reached by sprays or other external treatment. Results throughout this country show that it is possible practically to eliminate many diseases in this manner. However, the results also show that resistant strains which are satisfactory for one section of the country may be neither resistant nor satisfactory in another section. It is the opinion of the writer that one of the most important and profitable lines of work for New Jersey would be a series of experiments for the purpose of developing resistant varieties. The most urgent problems of this kind at the present time are with tomatoes, cabbage, celery and alfalfa.

NEEDS

The most important demands for special studies at this time are as follows:

1. Studies on pathogenic organism in the soil and the best methods for their control. This involves the problem of seed-bed sterilization referred to above.
2. Studies for the development of varieties of crop plants resistant to diseases, especially for those diseases for which there is no other known method of control.
3. Studies on potato diseases for the purpose of determining (a) the extent to which certain diseases are carried in or on the tubers, (b) the extent to which diseases are eliminated by the growing of very late crops to be used as seed the following year, and (c) the extent to which the foliage diseases can be controlled with profit by spraying.
4. Studies of the *mosaic* and other diseases of the tomato.
5. Studies on the wilt of eggplant.
6. Studies on the diseases of celery.
7. Studies on the diseases of legumes, especially alfalfa.
8. Studies on the diseases of shade and ornamental plants.
9. The importance of plant disease organisms as destroyers of perishable products in storage and during shipment is attracting a great deal of attention at this time and some steps should be taken to bring the facts before our New Jersey producers and to pursue studies along this line.

The Herbarium

Unfortunately our herbarium has been neglected for several years. The mounted plants should be gone over carefully and arranged in accordance with the up-to-date researches in taxonomy. Several hundred unmounted plants should be mounted and properly distributed so that they can be used to advantage.

PUBLICATIONS

The following publications have been issued November, 1917.

Circular 88. Common diseases of berries. Mel. T. Cook.
Circular 89. Common diseases of garden vegetables and truck crops. Mel. T. Cook.
Circular 93. Spray calendar for apples and quinces. T. J. Headlee, M. T. Cook, M. A. Blake and A. J. Farley.
Circular 94. Spray calendar for the peach. T. J. Headlee, M. T. Cook, M. O. Blake, and A. J. Farley.
Circular 95. Seed and soil treatment for the control of potato scab. H. Clay Lint.
Circular 96. Leaf blight of the tomato. Mel. T. Cook and W. H. Martin.
Circular 97. Common diseases of ornamental plants. Mel. T. Cook.
Martin, G. W., 1918. Brown blotch of the Keiffer pear, *Phytopathology*, v. 8, p. 234-240.

LIST OF PLANT DISEASES

Having published a list of the plant diseases of 1917 in our last report we have very few to add at this time. We consider it advisable to withhold this brief list and incorporate it in the next annual report.

PLANT DISEASE SURVEY

The United States Bureau of Plant Industry has established a Plant Disease Survey which is being conducted in cooperation with the departments in the different states. This work of the department is of the greatest importance, especially at this time. Had much of the information which we are now gathering been available at the beginning of the war, it would have been an important factor in the food production of our country.

REPORT

of the

Department of Plant Pathology

of the

NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION

[illegible]

to

[illegible]

[illegible]

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

*WILLIAM H. MARTIN, PH.D., *Associate Plant Pathologist.*

†GERTRUDE E. MACPHERSON, A.B., *Research Assistant.*

‡L. M. MASSEY, PH.D., *Extension Specialist in Plant Pathology.*

*Appointed January 1, 1919.
†Appointed September 1, 1918.
‡Detailed for work in New Jersey by the United States Department of Agriculture.

CONTENTS

ORGANIZATION 523
WORK OF THE PAST YEAR 523
RESEARCHES 523
EPIDEMICS 524
WARNINGS 524
DISEASE-RESISTANT PLANTS 525
PUBLICATIONS 525
NEEDS 525
THE HERBARIUM 526
PLANT DISEASE SURVEY 526
LIST OF PLANT DISEASES 526
REPORT OF PROGRESS IN CONTROL DEMONSTRATIONS 535
POTATOES 536
TOMATOES 537
SWEET POTATOES 541
PROGRAM OF WORK FOR THE ENSUING YEAR 543
GENERAL CONSIDERATIONS 543

Report of the Department of Plant Pathology

MEL. T. COOK

ORGANIZATION

The staff of the department at present includes Dr. William H. Martin, who began work January 1, 1919, giving about one-fourth of his time to the department of plant pathology. He is giving special attention to the diseases of potatoes and methods of control. Miss Gertrude E. Macpherson is laboratory assistant.

Dr. L. M. Massey, of the United States Department of Agriculture, who has been with us during the past year as extension specialist, left us on June 30, 1919. This was necessary because Congress failed to make the necessary appropriation for the continuation of the line of work pursued by Dr. Massey.

Erdman West, special inspector employed by the State Department of Agriculture, has his headquarters in this office. Harry W. Lutz, of the United States Department of Agriculture, has been assigned to New Jersey for the purpose of scouting for blister rust of the white pine.

WORK OF THE PAST YEAR

Because of war conditions our work for the past year was very much modified, but with the return of peace, it is hoped that more attention can be given to research work. However, the heavy correspondence, requests for special inspection and other duties of an extension character, required so much of our time that the research is very much reduced. The department is in very great need of an extension specialist well trained in plant pathology, who can attend to the many duties of this character.

Researches

I. Studies on the diseases of potatoes and methods of control by Dr. W. H. Martin.

II. Studies on the influence of spraying mixtures on potatoes by Dr. Mel. T. Cook, assisted by Miss G. E. Macpherson.

III. Studies on fruit tree cankers by Dr. Mel. T. Cook.

IV. Studies on methods of control of fire blight by Dr. Mel. T. Cook.

V. Studies on the life history and parasitism of dodder by Miss G. E. Macpherson.

VI. Studies on the corn root rot by Dr. I. C. Hoffman, of the United States Department of Agriculture.

VII. Studies of the diseases of celery will be resumed immediately on the return of R. F. Poole.

Epidemics

The most severe epidemic of the past year has been the brown rot of the peach during the spring of 1919. This is the first severe outbreak of the disease at this season of the year, that we have had in New Jersey. The method of transmitting the disease from year to year is being studied, with the hope that we will be able to devise methods for its control another year (plate 1).

There was a severe outbreak of late blight of the potato in Mercer, Monmouth, and Middlesex counties in July, 1918.

Fortunately, the foliage of the potatoes was rather thin and the weather conditions unfavorable for the spread of the disease. Therefore, the loss was not as great as might otherwise have been expected. The 1918 crop of potatoes in the southern half of the state was very greatly reduced by dry weather, accompanied by tip-burn and early blight.

The fire blight of pear and apple was quite severe in 1918, and will probably be equally severe during 1919.

There was a severe outbreak of the root rot of peas throughout the southern half of the state in the spring of 1919. This emphasizes the recommendations frequently made by this department concerning the importance of special studies on the diseases of legumes. These crops are of very greatest importance in this state and the diseases attacking them are very destructive and not well understood.

Warnings

There has been an outbreak of the European potato wart disease over a limited area of 3 counties in Pennsylvania. This is one of the most destructive diseases of the potato and was evidently introduced into this country on foreign potatoes about 1912, just previous to the establishment of the quarantine prohibiting the importation of potatoes from the main parts of Europe (plate 2, fig. 1).

There has been an outbreak of the European nematode disease of wheat in Virginia and an outbreak of what appears to be the "take-all" disease and "flag smut" disease of the wheat in Illinois and Indiana. These diseases are extremely destructive and their character is such that the only safeguard consists in using home-grown seed.

Disease-Resistant Plants

Your attention is again called to the importance of the growing of strains of crop plants resistant to diseases. This work is being carried on in the plant pathology departments of many states, and is giving most excellent results. There are many diseases in New Jersey that could be greatly reduced by work of this kind.

Publications

The following publications have been issued since our last report:

Circular 98. Common Diseases of Shade and Ornamental Trees.
Circular 102. Diseases of Grain and Forage Crops. Revision of Circular 36.
Circular 104. Diseases of Tomatoes. Revision and consolidation of Circulars 71 and 97.
Circular 105. Potato Diseases in New Jersey. Revision of Circulars 53 and 95.
Circular 106. Seed and Soil Treatment for Vegetable Diseases.

Needs

The greatest needs of the department may be summarized as follows:

I. Assistance to our force for the purpose of making research studies on many important diseases which are not well understood.

II. An extension pathologist who can attend to the many demands made upon the department.

III. Studies on pathogenic organisms in the soil.

IV. Studies for the development of varieties of crop plants resistant to diseases, especially for those diseases for which there is no other known method of control.

V. Studies on potato diseases for the purpose of determining (a) the extent to which certain diseases are carried in or on the tubers, (b) the extent to which diseases are eliminated by the growing of very late crops to be used as seed the following year, (c) the extent to which the foliage diseases can be controlled by spraying with profit.

VI. Studies of Mosaic and other diseases of the tomato.

VII. Studies of the root diseases of corn and other cereals.

VIII. Studies of the wilt of eggplant.

IX. Studies on the diseases of celery.

X. Studies on the diseases of legumes, especially alfalfa, peas and crimson clover.

XI. Studies on the diseases of shade and ornamental plants.

XII. The importance of plant-disease organisms as destroyers of perishable products in storage and during shipment is attracting a great deal of attention at this time and some steps should be taken to bring the facts to our New Jersey producers and to pursue studies along this line.

The Herbarium

Unfortunately, our herbarium has been neglected for several years. The mounted plants should be gone over carefully and arranged in accordance with the up-to-date researches in taxonomy. Several hundred unmounted plants should be mounted and properly distributed so that they can be used to advantage.

Plant Disease Survey

The United States Bureau of Plant Industry has established a plant disease survey which works in cooperation with the departments in the different states. The work of this department is of the greatest importance, especially at this time. Had much of the information which we are now gathering been available at the beginning of the war, it would have been an important factor in our food production.

List of Plant Diseases

The following is a list of important diseases which have been reported to this office during the past year:

ALFALFA

LEAF SPOT (*Pseudopeziza medicaginis* (Lib.) Sacc.) This disease has been about the same this year as in past years. It causes a shattering of the leaves, which means a great reduction in the feeding value of the crop.

WHITE SPOT (cause undetermined). Prevalent, but not causing a falling of the leaves. We also find a similar spotting on the clovers. Thus far it is of practically no economic importance.

LEAF SPOTS (*Pleospora* sp. and *Cercospora medicaginis* E. & E. *Stagnospora carpathica*). Occasional.

Several undetermined leaf spots, which may have been incipient stages of some of the above, or due to some other causes, were sent in from time to time.

Note: The diseases of alfalfa promise to increase in importance. The problem involves the selection of varieties, cultural methods and the study of the diseases. It will necessitate the combined work of the agronomist and the plant pathologist.

Ampelopsis

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was quite common on the lower part of ivy plants on buildings, and was a very serious pest in nurseries. It attacks both *A. quinquefolia* and *A. tricuspidata*.

DIE-BACK (*Cladosporium* sp.). This disease occurs on *A. tricuspidata*. We have had very little complaint concerning it during the past year.

Apple

JONATHAN SPOT (*Alternaria* sp.). A peculiar spotting of the Jonathan is without doubt due to this organism. It has been very severe during the past year.

Other very similar spots are no doubt due to other causes. The study of these minor apple spot rots is of greater importance than is at first apparent. They no doubt serve as points of infection for other and more serious rot organisms.

BLOSSOM END ROT (*Alternaria* sp.). Occasional. The same symptoms can be produced by *S. malorum*.

ANTHRACNOSE or BITTER ROT (*Glomerella rufomaculans* (Berk.) S. & Von S.). Several records. More common than usual.

BLACK ROT (*Sphaeropsis malorum* Pk.). Common and severe on unsprayed orchards. It frequently appears in the orchard as a blossom end rot, similar to that produced by *Alternaria* sp.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni.). Very severe and the cause of many losses, but less severe than in 1915.

BLOTCH (*Phyllosticta solitaria* E. & E.). This disease has been very severe on some varieties, especially Smith's Cider and Roman Stem, but no more severe than in previous years. The regular spray treatment given in our cal-

of strains of crop plants resistant to diseases. This work is being

endar controls it.

SOOTY BLOTCH (*Phyllachora pomigena* (Schw.) Sacc.). Common in unsprayed orchards.

SCAB (*Venturia pomi* (Mont. & Fr.) Sacc.). This disease was prevalent throughout the state, but did not reach the proportion of an epidemic.

BROWN ROT (*Sclerotinia fructigena* (Per.) Schroet.). Occasional.

PINK ROT (*Cephalothecium roseum* Cda.). Common but not important.

LEAF SPOTS (*Phyllosticta pyrina* Sacc.) (*Sphaeropsis malorum* Pk.). Common and about as severe as usual.

RUST (*Gymnosporangium juniperi-virginianae* Schw.). Very common in Cape May County and frequently collected in small quantities in other parts of the state. *G. globosum*. Occasional. (Plate 2, fig. 2.)

CROWN GALL (*Pseudomonas tumefaciens* E. F. Smith & Townsend). Cases are frequently called to our attention where this disease injures the trees.

MEASLES (cause unknown). A peculiar roughness of young twigs. A few cases. Of little or no importance.

WATER CORE. Occasional.

SPRAY INJURY. Occasional.

WINTER INJURY. Very severe.

Asparagus

RUST (*Puccinia asparagi* De C.). This disease occurred in various places, but not in sufficient quantity to be of any importance.

Barley

SMUT (*Ustillago nuda* (Jens.) Kell. & Sw.). Common, but of very little importance.

POWDERY MILDEW (*Erysiphe graminis* D. C.). Occasional.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). Less than usual.

LEAF AND POD SPOTS (*Diaporthe phaseolorum* (E. & E.) (Sacc.) Harter). Less than usual.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Common on Lima bean; especially on seedlings.

STEM ROT (*Sclerotinia libertiana* Fuckel). Occasional.

Beet

LEAF BLIGHT (*Cercospera beticola* Sacc.). Quite common.

Blackberry

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common and destructive.
LEAF SPOT (*Septoria rubi* West). Common.
RUST (*Gymnoconia interstitalis* (Schlt.) Lagerl.). Common and the subject of many inquiries.

Cabbage, Cauliflower and Kohlrabi

CLUB ROOT (*Plasmodiophora brassicae* Wor.). This disease was reported from many localities.
BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Reported frequently and in most cases very destructive.
YELLOWS (*Fusarium conglutinans* Wollenw.). Common and widely distributed throughout the state.
BLACK LEG (*Phoma lingam* Desmag.). Common and widely distributed throughout the state. (Plate 3, fig. 1.)

Cantaloupe

(See Muskmelon)

Carnation

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.
ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

Catalpa

LEAF SPOT (*Phyllosticta catalpae* Ell. & Mart.). Common.

Note: These leaf diseases were accompanied by a falling of the leaves which many people supposed to be due to the disease. The spotting was no more severe this year than in previous years, and the falling was probably due to other causes.

Cedar

RUST (*Gymnosporangium juniperi-virginianæ* Schw.) (*Gymnosporangium germinale* (Schu.) Kern.). Reported, but of little importance. The former was most abundant in Cape May County. *G. botryapites* was found to be quite abundant in Atlantic County.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Reported from several places. Very destructive.
LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Very abundant in certain localities and most important celery disease in the state.
CROWN ROT (Bacterial ?). Very severe in many localities.

HEART ROT (Bacterial ?). Very severe in many localities.
ROOT ROT (*Sclerotinia libertiana* Fuckel). Sometimes severe in the seed-beds.

Cherry

BROWN ROT (*Sclerotinia cinerea* (Bob.) Wor.). Common.
LEAF SPOT (*Cylindrosporium padi* Karst.). Common.
WINTER INJURY. Several complaints.

Chestnut

BARK DISEASE (*Endothia parasitica* (Mur.) Ander.). Common throughout the state.
LEAF SPOT (*Actinopelte japonica* and *Marssonia ochroleuca* B. & C.). Frequent.

Crimson Clover

CROWN ROT (*Sclerotinia libertiana* Fuckel). Occasional.

Red Clover

RUST (*Uromyces trifolii* (Hedw.) Lev.). Occurs throughout the state, but is of very little importance.

Corn

SMUT (*Ustilago zeae* (Beckm.) Ung.). This is very common and very widely distributed disease; is not often serious except on sweet corn.
WILT (*Pseudomonas stewarti* Erw. Smith). One definite report.
RUST (*Puccinia sorghii* Schw.). Not serious.
LEAF BLOTCH (*Helminthosporium insconspinum* C. & E.). Common. Farmers attribute this to weather.
ILLINOIS BACTERIAL DISEASE. Common, and in some cases very destructive.
ROOT AND EAR ROTS (*Gibberella saubinettii* (Mont.) Sacc.) (*Fusarium*). Common, and in some cases very destructive. Complicated with Illinois Bacterial Disease.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Frequent.

Cranberry

SCALD (*Guignardia vaccinii* Shear.). This disease was widely distributed throughout the state, and the cause of considerable loss where the bogs were not well sprayed.

Cucumber

WILT OR BLIGHT (*Bacillus tracheiphilus* Erw. Smith). Very widely distributed and the couse of considerable loss.
DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common, and frequently the cause of heavy losses.
LEAF SPOT (*Macrosporium cucumerum* E. & E.). Frequent.

STEM ROT (*Sclerotinia libertiana* Fuckel). Occasionally severe in greenhouses.

MOSAIC (cause ?). Frequent.

Currants

CANE BLIGHT (*Botryosphaeria ribis* G. & D.). Very severe and destructive, especially in the southern part of the state.

LEAF SPOT (*Septoria ribis* Desm.). Very common.

RUST (*Peridermium strobi* Kleb.). Four infections found in one place in the state. Two infected pines in our locality and one in another (see page 532).

Dewberry

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). This disease continues with equal severity where the nurserymen and growers do not try to control it. However, many of our most progressive men are keeping it well under control by hand-picking the diseased buds in the season. It is most severe on Lucretias, Rathbune and Black Diamonds.

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Very abundant and in some cases destructive.

LEAF SPOT (*Septoria rubi* West.). Common.

RUST (*Gymnoconia interstitialis* (Schlt.) Lagerl.). Reported as common and in some cases destructive.

Eggplant

LEAF BLIGHT (*Phomopsis vexans* (Sacc. & Syd.) Harter). Very common and in some cases destructive.

WILT (*Verticillium albo-atrum* R. & B.). Common and destructive throughout the state.

ROOT ROT (*Rhizoctonia* sp.). Very destructive.

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). Gloesporium stage has been found in several places.

LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* (Ell.) Viala & Ravaz). Common and very destructive in many vineyards in the southern part of the state.

ANTHRACNOSE or BIRD'S EYE ROT (*Gloeosporium ampelophagum* Sacc.) Occasional.

RIPE ROT (*Gloeosporium fructigenum* Berk.). Occasional.

NECROCIS (*Fusicoccum viticolum* Reddick). Occasional.

DOWNY MILDEW (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.

BITTER ROT (*Melanconium fuligineum* (S. & V.). Occasional.

WINTER INJURY. Severe (see page).

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common.

Horse-Chestnut

LEAF BLOTCH (*Phyllosticta paviae* Desm.). Very common.

Juniper

RUST or CEDAR APPLE (see apple, page 527).

Lettuce

DROP (*Sclerotinia libertiana* Fuckel). Very common and the cause of heavy losses, especially in cold-frame crops.

Lilac

MILDEW (*Microsphaera alni* Wallr. Wint.). Abundant throughout the state.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Common.

Maple

TAR SPOT (*Rhytisma acerinum* (P.) Fr.). Occasional.
LEAF SPOT (*Phyllosticta acericola* C. & E.). Common.
LEAF SCALD (*Physiological*). Many complaints.
WINTER INJURY. Occasional.

Mushroom

MYCOGONE (*Mycogone perniciosa* C. & D.). One record from mushroom house.

Muskmelon

WILT or BLIGHT (*Baccillus tracheiphilus* Erw. Smith). Common and destructive in some cases.
DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common but not severe.

Oats

SMUT (*Ustillago avenae* (Pere.) Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia triticina* Eriks.). Common.
RUST (*Puccinia graminia* Pers.). Occasional.

Okra

WILT (*Verticillium albo-atrum* R. & B.). Abundant in one locality, but this crop is of little importance in the state.

Onion

SMUT (*Urocystis cepulae* Frost). Report from two localities and very severe in one. (Plate 3, fig. 2.)
ANTHRACNOSE (*Vermicularia cercinans* Berk.). Found on the local markets.

Pea

LEAF SPOT (*Asocchyta pisi* Lib.). Occasional.
MILDEW (*Erysiphe polygoni* D. C.). Reported.

Peach

BROWN ROT (*Sclerotinia cinerea* (Bob.) Wor.). Common throughout the state. Severe on fruit in unsprayed orchards.
CANKERS (*Valsa* sp. & *Sclerotinia cinerea*). Very severe in one orchard.
CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith and Townsend). Common. (See apple, page 527.)
LEAF CURL (*Exoascus deformans* (Berk.) Fuckel). Abundant where the orchards were not sprayed.
SCAB (*Cladosporium carpophilum* Thum.). The severity of this very common disease varied with the thoroughness of spraying.
SHOT-HOLE (*Bacterium pruni* Smith). Much more severe than usual. In some cases caused injuries similar to hail-stone injury.
YELLOWS AND LITTLE PEACH. Much more severe than usual, frequently causing heavy losses in well-kept orchards, which previously were comparatively free from disease.
WINTER INJURY. Severe (see page).

Pear

FIRE BLIGHT (*Baccillus amylovorus* (Burr.) DeToni). Common. (See apple, page 527.)
LEAF BLIGHT (*Fabreæ maculata* (Lev.) *Entomosporium* stage). Abundant on leaves and fruit. This disease is likely to cause severe losses in good crop years unless the growers give more attention to its control.
LEAF SPOT (*Septoria pyricola* Desm.). Abundant.
BROWN BLOTCH (cause undetermined). Less than usual.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common in fall.
ROT (*Macrosporium* sp.). Common on fruits and also found on seeds. May have been secondary.
MOSAIC (cause undetermined). Very severe and the cause of heavy losses.
SUN SCALD. Common and followed by rots.

Pine

RUST (*Peridermium strobi* Kleb). The much-feared European blister rust was found in two localities this year. Every possible effort is being made to eradicate it. (See rust on currant, page 530, and also see page .)
DIE-BACK (*Diplodia* sp.). On Austrian pines. (Plate 4.)

Poplar

LEAF SPOT (*Marsonia populi* Lib. Sacc.). Common.
CANKER (*Dothichiza populae* S. & B.). Common but not attracting much attention.

Potato

SCURF (*Rhizoctonia or Corticium vagum* D. & C. var. *solani* Burt.). This very widely-distributed disease was the cause of considerable losses.

BLACK LEG (*Bacillus phytophthorus* Appel). Rare; evidently reduced by greater care in the northern potato growing districts.

SCAB (*Actinomyces chromogenus* Gast.). This disease was fully as severe as in past years.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). This disease was more abundant following a severe outbreak of tip burn. It is more important on the late than on the early crops.

LATE BLIGHT (*Phytophthora infestans* De By.). This disease was not reported, but probably occurred in the mountainous districts.

TIP BURN. Much more severe than usual and the cause of heavy losses.

ROLL LEAF (cause unknown). Very common and evidently caused a reduced yield.

MOSAIC (cause unknown). Very common and undoubtedly caused a reduced yield.

SHOE-STRING (cause unknown). Long stolons and poor yield. Common on Irish Cobblers. (Plate 5.)

Phlox

POWDERY MILDEW (*Prysiphe communis* (Wahl.) Schl.). Common.

Privet

WINTER INJURY. Very destructive, especially in the northern part of the state.

Plum

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the state.

BROWN ROT (*Sclerotinia cinera* Bon. Wor.). Common throughout the state.

SHOT HOLE (*Phyllosticta circumsissa*). Occasional.

LITTLE PLUM (cause undetermined). Occasional.

Quince

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe. (See apple, page 527.)

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Abundant and severe. (See apple, page 527.)

RUST (*Rostellia aurentiana* Peck). Occasional.

FRUIT AND LEAF SPOT (*Fabrea maculata*).

Raspberry

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Abundant and destructive.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Abundant. (See apple, page 527.)

LEAF SPOT (*Septoria rubi* West.). Abundant.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Very abundant and destructive.

Rose

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend). Frequent.

ANTHRACNOSE (*Gloeosporium rosæ* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosea* (Lib.) Fr.). Common and very severe in the greenhouse.

POWDERY MILDEW (*Sphærotheca pannosa* (Wallr.) Lev.). Common, and more severe than usual.

LEAF SPOT (*Phyllosticta rosicola* Massal.). Abundant and frequently confused with black spot.

CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common and the cause of many complaints.

Rye

ERGOT (*Claviceps purpurea* (Fr.) Tul.). Two records. Not serious.

Spinach

MOSAIC (Cause?). So complicated with plant lice that it is impossible to give any definite statement.

Strawberry

LEAF SPOT (*Mycosphaerella fragariæ* (Tul.) Lidau.). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

LEAF SPOT (*Marsonia potentillæ* (Desm. Fisk). Frequent.

WINTER INJURY. Frequent.

POWDERY MILDEW (*Oidium fragariæ* Harz.). Occasional. (Plate 6.)

Sweet Potato

BLACK ROT (*Sphæronema fimbriatum* (E. & H.) Sacc.). Less abundant than usual.

WET ROT (*Rhizopus nigricans* Ehr.). Common in storage.

STEM ROT or YELLOW ROT (*Fusarium batatatis* Wollen). Most severe disease in 1918.

ROT (*Diaporthe batatatis* Harter & Field). The Phoma stage. Common.

CHARCOAL ROT (*Sclerotium bataticola* Taub.). Frequent.

ROT (*Trichoderma koenigii* Ould). (*Fusarium hyperoxysporium*, and *F. batatatis*). Common.

FOOT ROT (*Plenodomus destruens*). Common.

ROT (*Penicillium sp.*). Common in storage, probably secondary.

SCURF or SOIL STAIN (*Monilochaetes infuscans* E. & H.). Common.

POX (*Cytospora batata*). Common.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* (Sacc. & Speg.) Kelb.). Very abundant.

Tomatoes

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). Common, but not severe.

FRUIT ROT (*Macrosporium solani* E. & M.). Abundant and severe, especially on sun-burned fruits.

STEM BLIGHT (*Fusarium lycopersici* Sacc.). Common and very severe in some localities.

BLOSSOM END ROT (Cause questionable). Common and much more severe than usual.

LEAF SPOT (*Septoria lycospersici* Speg.). Abundant, but less severe than usual.

MOSAIC—Filiform Leaf (Cause undetermined). Less severe than usual.

SUN BURN. Severe and followed by fruit rots.

Watermelon

ANTHRACNOSE (*Colletotrichum lagenarium* (Passe.) (E. & H.). Common. This crop is of very little importance in the state.

Wheat

RUST (*Puccinia coronata* Cda.); common. (*Puccinia graminis* Pers.); occasional. (*Puccinia rubigo-vera* (deC.) Wint.); common. (*Puccinia triticina* Eriks.); common.

SMUT (*Tilletia fœtens* (B. & C.) Trel.); frequent. (*Tilletia tritici* (Bei.) Wint.); abundant.

SMUT (*Ustillago tritici* (Pers.) Jens.). Common.

MOLD (*Cladosporium herbarum* (Pers.) Lk.). Abundant in places.

SCAB (*Gibberella saubinetii* (Mont.) Sacc.). Very common and more destructive than usual.

REPORT OF PROGRESS IN DEMONSTRATIONS ON THE CONTROL OF DISEASES OF POTATOES, SWEET POTATOES, TRUCK CROPS, FORAGE CROPS, AND RELATED PLANTS IN NEW JERSEY, FOR THE PERIOD APRIL 1 TO DECEMBER 1, 1918

L. M. MASSEY

Extension work in plant pathology in New Jersey was begun on April 1, 1918, and was carried out in accordance with an agreement between the Office of Cotton, Truck and Forage Crop Disease Investigations of the United States Department of Agriculture and the extension division of the New Jersey State College of Agriculture. The salary and traveling expenses of the extension pathologist were paid from the war emergency appropriation by Congress for "Stimulating Agriculture and Facilitating Distribution of Products." The primary purpose of the work was to secure the adoption of the best known methods of controlling important crop diseases to effect conservation of the food supply. Office and laboratory facilities were furnished by the New Jersey State College of Agriculture, with whom the work was cooperatively planned and executed.

The extension work covered by this report was begun April 1, 1918. At that time of year, and also since the extension specialist was unacquainted with conditions in the state, it was inadvisable, and in some instances impossible, to undertake several desirable lines of work. Before undertaking any demonstration work a visit was made to each county agent in order to become acquainted with the men and with the disease problems of the counties. Considerable miscel-

laneous work—work of an advisory nature—has been welcomed in order that the specialist may become better acquainted with state needs. In general the work of the past season may well be considered preliminary to well organized and comprehensive work in the future.

An effort has been made to emphasize the large problems—and those for the solution of which practical methods of control have been demonstrated—of staple crops. Three of the most important crops in the state are potatoes, tomatoes and sweet potatoes, and it is on these crops that the greatest amount of work has been done this past season.

Potatoes

It is recognized that the use of good seed is one of the most important factors in potato culture. Reports of growers and others interested in potatoes indicated that good results have been obtained from the use of northern-grown certified seed. However, the use of northern seed is very limited. This condition may be explained by: (1) the limited amount of northern-grown certified seed; (2) the confusion of inspected with certified seed; (3) the use of home-grown second-crop potatoes for seed, which was begun about the time certified seed became available, has given good results and has brought about the elimination of black-leg and late blight. However, enormous losses have resulted in the past year from the use of poor seed, and it is believed that the seed situation demands organized effort for improvement on the part of the New Jersey potato growers.

Although the results of experiments conducted by the department of plant pathology during the past six years indicate that the spraying of early potatoes with Bordeaux mixture is not profitable, an additional test was made the past season on the farm of D. Budd Jones, of Vincentown. The grower was very desirous of running the demonstration and undertook the work with the understanding that it was probable that no gain would result from spraying. Spraying with Bordeaux mixture was regularly practiced by the growers of this community, and the results of the demonstration were watched with interest.

Following is a report of the work:

A field of potatoes (Cobblers) comprising about 15 acres, was divided into 5 equal plats and sprayed as follows:

Plat 1—(30 rows, about 3 acres) sprayed with home-made Bordeaux mixture, 5-5-50, plus 1½ lbs. dry arsenate of lead.

Plat 2—Sprayed with arsenate of lead, 2 lbs. to 50 gallons of water.

Plat 3—Sprayed with home-made Bordeaux mixture, 5-5-50, plus 1½ lbs. arsenate of lead.

Plat 4—Sprayed with a proprietary Bordeaux-lead mixture. Adheso-Green label, made by the Ausbacher Insecticide Company, of New York. Used at the recommended strength.

Plat 5—Sprayed with a proprietary Bordeaux mixture, Tiger-brand Bordeaux-lead, made by the Inter-State Chemical Company, of Newark, N. J. Used at the recommended strength.

Applications were made on May 27, June 5 and June 15. A power sprayer with which a pressure of 200 pounds could be maintained was used and the material applied at the rate of 100 gallons per acre. Three nozzles to the row were used.

No late blight (*Phytophthora infestans*) appeared during the season. There was a slight amount of early blight (*Alternaria solani*) and some tip-burn. No difference in the amount of these troubles could be noted on the various plats. A 6-weeks' period of drought, beginning about June first, together with a heavy infestation of aphids, caused the early and premature death of the vines.

The potatoes were dug on July 19-20, a 6-row strip ($^3/_5$ acre) from the middle of each 30-row plat being dug first and a record kept of the number of baskets obtained. The following results were recorded:

Plat 1—144 baskets (⅝ bushel)
Plat 2—148 baskets (⅝ bushel)
Plat 3—142 baskets (⅝ bushel)
Plat 4—140 baskets (⅝ bushel)
Plat 5—136 baskets (⅝ bushel)

The difference in yield in the several plats is readily explained on the basis of experimental error. Good beetle control was obtained in all plats.

The results of this demonstration are in accord with those obtained in previous work of the department of plant pathology and lead to the conclusion that it does not pay to spray early potatoes in New Jersey with Bordeaux mixture.

Tomatoes

The most important disease of the tomato in New Jersey is blight, or leaf spot, caused by the fungus *Septoria lycopersici*. The results of experiments conducted by the department of plant pathology cooperating with the Office of Cotton, Truck and Forage Crop Disease Investigations of the United States Department of Agriculture, showed that the disease could be profitably controlled by spraying with a mixture consisting of 4 pounds of copper sulfate, 2 pounds of lime and 3 pounds of resin-fish-oil soap to 50 gallons of water. The experimental work was done on the J. B. Campbell Soup Company's farm, at Riverton. It remained for this work to be duplicated in different sections of the state, under the direct supervision of the specialist before general recommendations could be made and the work turned over to county agents.

Twelve growers, recognized as leaders in their communities, who were especially interested in the control of leaf spot and who had suitable spraying apparatus, were selected for cooperators. Of this number seven made one or more applications of the spray mixture and four made the required number of applications and kept records of their work. The shortage of labor and the over-production of tomatoes this season were instrumental in causing the discontinuance of the work by eight of the cooperators.

The names and addresses of the cooperators, together with data relative to the work, are given below.

Messrs. Bell & Forsyth, Sewell, Gloucester County

1. Name of variety—Greater Baltimore.
2. Number of acres sprayed experimentally—1½.
3. Number of acres left unsprayed for experiment—1½.
4. Acreage from which records were kept—
   a. Sprayed—$^4/_7$ acre.
   b. Unsprayed—$^4/_7$ acre.
5. Yield from sprayed plat..... 233 baskets, ⅝-bushel, 7.135 tons per acre
6. Yield from unsprayed plat... 184 baskets, ⅝-bushel, 5.635 tons per acre

6A. Gain from spraying..... 49 baskets; 1.5 tons per acre

7. Number of applications of spray—6.
8. Dates of applications of spray—July 2, 12, 23 and August 3, 12 and 20.
9. Dates of fruit picking (when not available number of pickings, and date of first and last)—Sprayed, August 15, 20, 21, 27, September 4, 7, 11, 21, 22; unsprayed, August 15, 21, 28, September 3, 10, 11, 22.
10. Opinion of the cooperator—"The unsprayed plat was more heavily set, but because the vines died much sooner did not yield as much in the last picking. On the unsprayed plat there were 28 baskets, and on the sprayed plat 62 baskets. The fruit on the latter was very nice, while that on the others were very small. We expect to spray all second early Baltimore next year."

A. R. Kohler, R. F. D., Westville, Gloucester County

1. Name of variety—Bonny Best.
2. Number of acres sprayed experimentally—3.
3. Number of acres left unsprayed for experiment—1.
4. Acreage from which records were kept—
   a. Sprayed—two-fifths (run in duplicate).
   b. Unsprayed—two-fifths.
5. Yield from sprayed plat—192½ and 175½* baskets (⅝ bushel).
6. Yield from unsprayed plat—191½ baskets.
7. Number of applications of spray—5.
8. Dates of applications of spray—July 18, 29; August 7, 19 and 29.
9. Dates of fruit picking (when not available number of pickings, and date of first and last given)—August 21, 28; September 4, 10, 14, 23, 27; and October 3, 10 and 18.
10. Opinion of the cooperator—"Spraying helped very materially in holding the foliage. Possibly if the tomatoes had been earlier, there would have been a gain in yield for the sprayed plats. There are large green ones on the sprayed plats now and very few on the unsprayed plat. Whether it would be worth while spraying next year I don't know."

D. Budd Jones, R. F. D., Vincentown, Burlington County

1. Name of variety—Bonny Best.
2. Number of acres sprayed experimentally—8.
3. Number of acres left unsprayed for experiment—2.

*Results of this plat indicate loss. Comparison of other plats indicate no increased yield from spraying.

4. Acreage from which records were kept—
   a. Sprayed—1.
   b. Unsprayed—1.
5. Yield of sprayed plat.... 432 baskets (⅝-bushel), 270 bushels
6. Yield of unsprayed plat.. 329 baskets (⅝-bushel), 205.675 bushels

6A. Gain from spraying.... 103 baskets (⅝-bushel), 64.375 bushels or 1.802 tons per acre

7. Number of applications of spray—5.
8. Dates of applications of spray—July 10, 20, 30 and August 5 and 20.
9. Dates of fruit picking (when not available number of pickings and dates of first and last given)—Two pickings before August 20.
10. The opinion of the cooperator—Acre sprayed with Bordeaux did not pick so soon, but did pick later on; more green tomatoes; vines held later in season.

**A. Clinton Clement, R. F. D., Westville, Gloucester County*

1. Name of variety—Red Rock.
2. Number of acres sprayed experimentally—1.86.
3. Number of acres left unsprayed for experiment—0.54.
4. Acreage from which records were kept—
   a. Sprayed—
   b. Unsprayed—
5. Yield from sprayed plat—325½ baskets (⅝-bushel) from 10 of the sprayed.
6. Yield from unsprayed plat—154½ baskets from 5 of the unsprayed.
*7. Number of applications of spray—2.
8. Dates of application of spray—July 1 and 11.
9. Dates of fruit picking (when not available number of pickings and dates of first and last given)—August 16, 22, September 5, 20, 28.
10. Opinion of the cooperator—I hardly think that it paid on account of the amount of trouble it is to apply the spray.

Frank VanNote, Farmingdale, Monmouth County

1. Name of variety—Greater Baltimore.
2. Number of acres sprayed experimentally—Approximately 1.
3. Number of acres left unsprayed for experiment—Approximately 0.37.
4. Acreage from which records were kept—
   a. Sprayed—0.093 acre.
   b. Unsprayed—0.093 acre.
5. Yield from sprayed plat, 1000 pounds, actually 0.5 tons, 5.37 tons per acre
6. Yield from unsprayed plat ..... 1300 pounds, actually .66 tons, 7.165 tons per acre

6A. Loss from spraying..... 333 pounds, 1.795 tons per acre

7. Number of applications of spray—6.
8. Dates of applications of spray—July 9, 19, 24; August 1, 16 and 24.
9. Dates of fruit picking (when not available number of pickings and dates of first and last given)—August 30; September 9, 16, 25; and October 1.
10. Opinion of the cooperator—Decided improvement in health of plants and fruit; yield not what expected from sprayed, but consider same due to close planting, therefore fruit and blossoms were destroyed by sprayer.

*But two applications—no results.

John Casazza, R. F. D., Vineland, Atlantic County

1. Name of variety—Stone.
2. Number of acres sprayed experimentally—2.
3. Number of acres left unsprayed for experiment—½.
4. Acreage from which records were kept—
   a. Sprayed.
   b. Unsprayed (market did not warrant harvesting crop).
5. Yield from sprayed plat—
6. Yield from unsprayed plat—
7. Number of applications of spray—5
8. Dates of applications of spray—July 15, 25; August 5, 17 and 27.
9. Dates of pickings—
10. Opinion of the cooperator—My vines were green and healthy on both sprayed and unsprayed plats, therefore cannot give an opinion.

Felix Donato, R. F. D., Vineland, Atlantic County

1. Name of variety—Baltimore.
2. Number of acres sprayed experimentally—9/10.
3. Number of acres left unsprayed for experiment—1 1/10.
4. Acreage from which records were kept—
   a. Sprayed—9/10 acre.
   b. Unsprayed—1 1/10 acre.
5. Yield from sprayed plat—
6. Yield from unsprayed plat—
7. Number of applications of spray—2.
8. Dates of applications of spray—July 15 and 25.
9. Dates of picking—
10. Opinion of the cooperator—We picked only two times but there was a great difference in yield. The plants which were sprayed were nice and green and the others were not. This shows that spraying is very important. Could not give you an opinion because we did not pick them all.

Of the four cooperators who completed the season's work it will be noted that two, namely, D. Budd Jones and Messrs. Bell & Forsythe, obtained increased yields of 1.8 tons and 1.5 tons per acre, respectively; that A. R. Kohler got no increase and that Frank VanNote registered a loss of 1.8 tons per acre from spraying. A fact to be taken into consideration in the results obtained by Mr. VanNote is that the acreage from which yields were taken was small, and that the records of yield were from adjacent rows of sprayed and unsprayed plants, the sprayed plants being thus subjected to abnormally favorable conditions for infection. The proximity of the rows may also have resulted in error in the records, due to the carelessness of the pickers.

In all instances where three or more applications of spray were made there was a marked decrease in the amount of leaf spot on sprayed plants as compared with those unsprayed. There were indications that the retention of the foliage through spraying resulted in a smaller percentage of sun-burned fruit. It is the opinion of the cooperators, as well as that of the specialist, that spraying caused a delay in the ripening of the fruit of from one to two weeks.

It is important that consideration be given to the prevalence of leaf-spot during the past season: A limited amount of the disease was present in most fields during the last week in June. Beginning about July 1 there occurred a 6-weeks' period of little or no rain throughout the southern part of the state, during which time leaf-spot practically entirely disappeared. With the occurrence of general rains over this section beginning about August 15, leaf-spot again made its appearance and continued to increase in severity throughout the remainder of the growing period. In general the disease was less severe than during an average year. As a rule, the disease starts about July 1 and develops rapidly and continuously throughout the summer and autumn.

Observations and the data obtained from demonstrations during the past season lead to the following conclusions:

1. Spraying with the resin-fish-oil-soap Bordeaux mixture will control leaf-spot.
2. The control of leaf-spot or blight in most cases will result in increased yield.
3. Spraying causes a delay of one to two weeks in the ripening of the fruit.
4. Because of the delay in the ripening of the fruit, spraying is of questionable value for tomatoes grown for the early market and for the late can-house tomatoes, where a delay may result in loss due to frost or weather unsuitable for ripening.
5. The greatest gains may be expected from the spraying of second early crop.
6. In sections where leaf-spot is prevalent an average increase of a ton or more per acre may be expected from spraying.
7. For the best results at least 5 applications should be made beginning before the disease ordinarily appears (about July 1) and should be continued until near the close of the season at 10-day or 2-week periods. At least 100 gallons per acre should be applied, a pressure of from 100 to 150 pounds maintained, and the machine should be fitted with a boom carrying 9 nozzles, 3 to a row.
8. Five applications of spray will cost about $12.00 per acre, assuming that a 3-row sprayer can cover from 10 to 12 acres per day, which can be done easily if water is reasonably convenient.
9. The results of the past season warrant additional demonstrations the coming year.

Sweet Potatoes

The most important diseases of the sweet potato in New Jersey are stem rot, black rot, scurf and storage rots (soft rot, ring rot, charcoal rot and dry rot). Practical methods of controlling these diseases have been developed. It is important to note that a large amount of the most important work on the control of the diseases of the sweet potato has been done in New Jersey in the important centers

for the growth of this crop around Swedesboro and Vineland. Experiments of a demonstration nature have been conducted at other places, and advice given to a large number of growers. The extent to which information had spread from centers where experiments and demonstrations have been conducted is striking and has resulted in the practice of better cultural methods.

A survey of the disease situation in the state led to the conclusion that, in general, work of the nature of propaganda rather than demonstrations would be more fruitful of results. The majority of sweet-potato growers, especially those who grow the crop on a large scale, are acquainted with the fact that demonstrations have been conducted, that the recommendations for disease control made by state college and experiment station and the United States Department of Agriculture are practical and will bring results, and are convinced that disease control is essential for the life of the sweet-potato industry in the state. In practically every community where the sweet potato is an important money-crop there is some grower who is having success by practicing recommended sanitary methods of culture. Therefore, it seemed advisable to do propaganda work in order to get a large number of growers interested in practicing methods which they knew would give results, rather than conduct a necessarily limited number of additional demonstrations. Results to date indicate the wisdom of this plan.

Opportunity has been welcomed throughout the season in visits among farmers who grow sweet potatoes to emphasize the presence of disease in their fields with the resulting decrease in yield. Three meetings of farmers interested in sweet potatoes were addressed in Atlantic County in June on disease control. Field meetings were held in Gloucester County and in Atlantic County at digging time and the proper method of seed selection demonstrated. In Gloucester County 12 meetings were held at the farms of leading growers, at which there was an attendance of 146. Fifty men pledged themselves to select seed in the demonstrated manner and to practice the other necessary measures to insure disease control. In Atlantic County 30 field demonstrations were held and about 50 cooperators secured. The work has resulted in the selection of from 1,500 to 2,000 bushels of seed from disease-free hills. Growers cooperating in this work will be visited during the winter, advised on storage problems, and receive aid in the spring in the additional selection of seed, seed-treatment and seed-bed preparation.

The scheme in brief for sweet-potato disease control is as follows:

1. Selection of seed from disease-free and high-producing hills.
2. Careful and proper handling and storing of seed.
3. Disinfection of storage houses.
4. Disinfection of seed at bedding time.
5. Disinfection of seed-beds, the use of clean soil in the seed-bed, and proper regulation of temperature and moisture.
6. Crop rotation.

Program of Work for the Ensuing Year

In accord with the policy of the extension division the following program of work is submitted for the coming year. The suggested projects are grouped under two sections—*special projects,* which relate to lines of work which will demand the immediate supervision of the extension specialist, and *general projects,* which relate to lines of work which the county agent should be able to carry, with the specialist acting in an advisory capacity. Demonstrations which might be handled by some county agents, might have to be carried by the specialist in other counties.

Special Projects

1. Spraying for tomato blight.
2. Seed-bed sterilization for
    a. Lettuce—damping off; drop.
    b. Celery—damping off; drop.
3. Control of sweet-potato diseases.
4. Control of celery leaf-spot by spraying.
5. Control of onion smut by formaldehyde.
6. Potato scab.
    a. Sulfur and bi-chloride (soil treatment).
7. Eggplant and okra wilt—seed-bed sterilization and crop rotation.
8. Wilt-resistant tomato for the Swedesboro section.
9. Certified seed.

General Projects

1. Sweet-potato disease control.
2. Control of bean anthracnose.
3. Control of black-rot and black leg of cabbage. Seed treatment and rotation.
4. Formaldehyde treatment of oats for smut (dry method).
5. Spraying for control of grape diseases.
6. Potato diseases.
    a. Spraying second-croppers in South Jersey.
    b. Seed treatment for scab and *rhizoctonia.*
    c. Use of certified seed.
7. Control of club root of cabbage.
8. Berry diseases.
    a. Cranberry—spraying.
    b. Dewberry—hand-pick for double blossom.
    c. Raspberry—pruning and spraying for anthracnose.

General Considerations

Diseases which have been very common and severe the past season are:

1. Eggplant-wilt and fruit rot.
2. Onion-smut—(seedling, two localities).
3. Potato-scab, *rhizoctonia,* mosaic and tip burn.
4. Lettuce-drop.
5. Cabbage-black rot, yellows, and club root.
6. Celery-blight.
7. Seedling-damping off.
8. Cucumber-mosaic.

9. Pea-mildew and stem blight.
10. Sweet potato-stem rot, black rot, scurf, and storage rots (black rot, soft rot, ring rot, dry rot and charcoal rot).
11. Tomato-leaf spot, mosaic and wilt.
12. Spinach-blight or mosaic.
13. Bean-anthracnose, and pod blight (of limas).
14. Pepper-leaf spot (bacterial).

Demonstrations are under way for the control of eggplant wilt and lettuce drop. Plans are being made to demonstrate the control of onion smut, potato scab and *rhizoctonia* and the damping off of seedlings. As given above a large amount of time is being given to the control of sweet-potato diseases and leaf-spot of tomato. Eggplant fruit rot, potato tip burn, cucumber mosaic, pea mildew and stem blight and tomato mosaic are subjects requiring further experimental work to demonstrate practical means of control. The use of disease-free seed-stock for potatoes will be urged. Seed treatment and crop rotation as preventive measures for the control of black leg, black rot and yellows of cabbage are to be recommended. Varieties of cabbage resistant to yellows and of tomatoes resistant to wilt are available and should be tested under New Jersey conditions. Celery blight can be controlled by spraying. Spinach mosaic or blight control is directly related to aphid control.

The specialist has felt the lack of a working basis such as only continued extension work in plant pathology in the state can establish. Observations of disease under field conditions throughout several seasons, the study of conditions peculiar to the state and certain sections of the state, and the study, from the plant pathologist's point of view, of environmental factors influencing both host and parasite, are of immense value to the extension worker for the most efficient fulfillment of his duties.

During the coming year special attention will be given to demonstration for the control of the important controllable diseases of the staple crops, potatoes, tomatoes and sweet potatoes, as in the past. As much of the less important work will be undertaken as time permits. It is realized that the work has not been equally distributed over the state the past year. Better understanding of the needs of the state, gained by the past season's work, together with more efficient organization, will enable the specialist more fully to handle future problems.

Much of the work of the past season has been made possible through the kind cooperation of Dr. M. T. Cook, head of the department of plant pathology, and the writer wishes to take this opportunity of expressing his sincere thanks.

Summary

Mileage for period April 1 to December 1	8000
Number of days spent in travel	100
(On road about 50 per cent of time.)	
Number of meetings held	54
Attendance at meetings—about	500
Growers cooperating	100

PLATE 1

Brown rot of the peach

PLATE 2

Fig. 1. The European potato wart; photograph of a Pennsylvania specimen (Courtesy of Prof. J. G. Sanders)

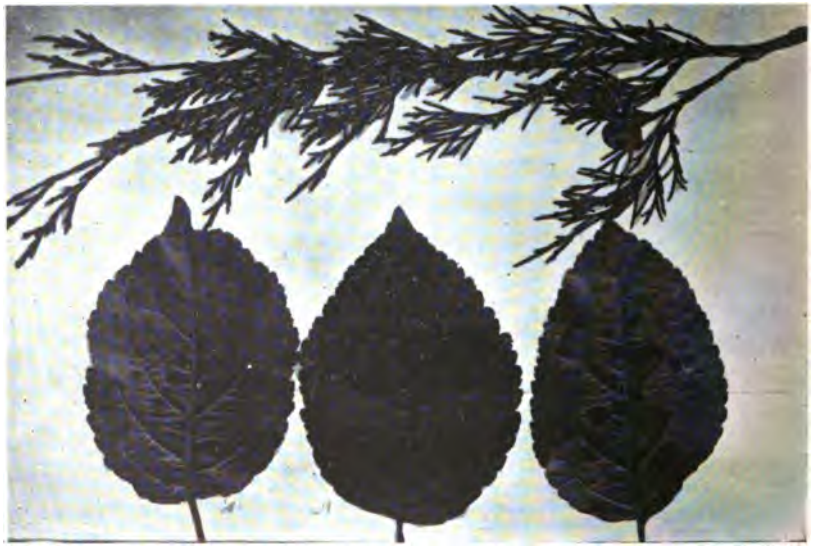


Fig. 2. Rust on both apple leaves and cedar

PLATE 3

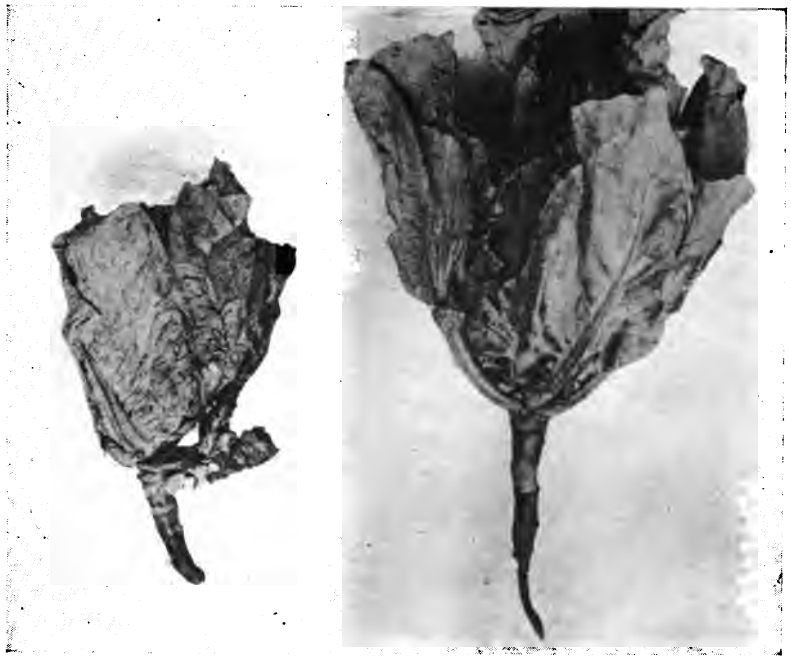


Fig. 1. Black-leg of cabbage

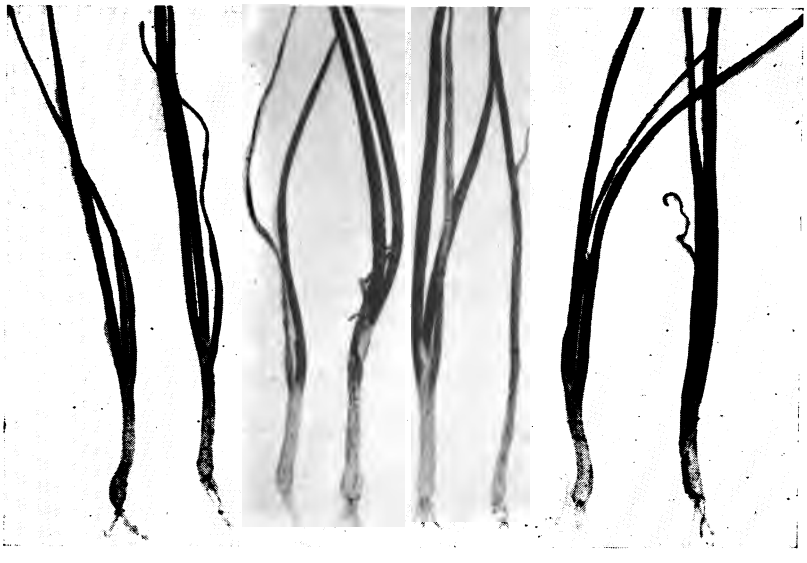
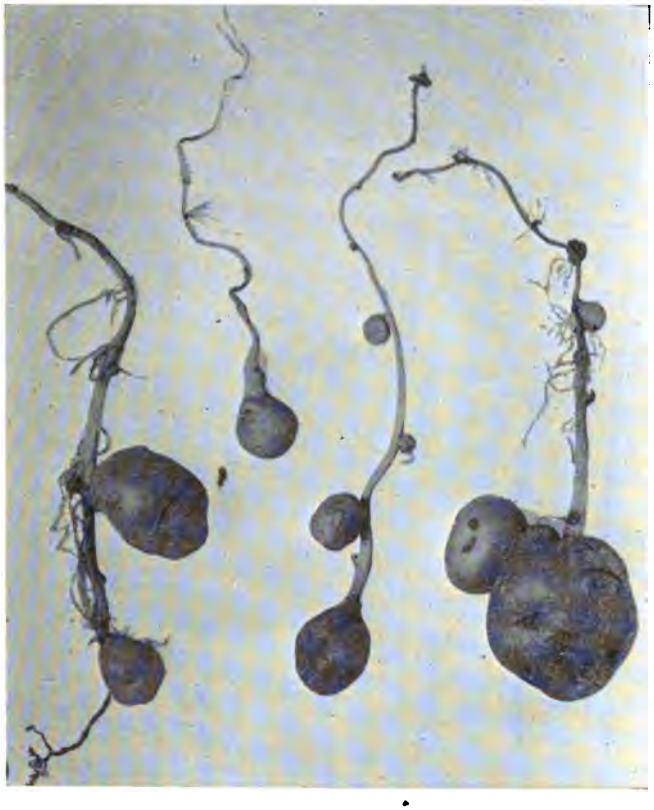


Fig. 2. Smut on onion seedlings

PLATE 4

Die-back on Austrian pines

PLATE 5



Shoe-string of Irish Cobbler potatoes; long stolons and poor yield

PLATE 6

Powdery mildew of the strawberry

REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
JUNE 30, 1920

TRENTON, N. J.
PUBLISHED BY THE STATE
1921

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., Plant Pathologist.
WILLIAM H. MARTIN, PH.D., Associate Plant Pathologist.
ROBERT F. POOLE, M.SC., Research Assistant.
C. M. HAENSELER, M.SC., Research Assistant.
*GERTRUDE E. MACPHERSON, Research Assistant.

* Resigned June 30, 1920.

CONTENTS

	PAGE
INTRODUCTION	557
RESEARCH	557
EPIDEMICS	558
OTHER IMPORTANT DISEASES	559
COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE	560
NEEDS OF THE DEPARTMENT	561
THE HERBARIUM	561
DISEASES OF THE YEAR	562
FIELD STUDIES ON POTATO DISEASES	573
REPORT OF POTATO SPRAYING TESTS	577
SEED TREATMENT FOR THE CONTROL OF POTATO SCAB	587
THE INFLUENCE OF SULFUR ON SOIL ACIDITY AND THE CONTROL OF POTATO SCAB	590
REPORT OF CORN ROOT AND STALK ROT INVESTIGATIONS, 1919,	598
FUNGI INJURIOUS TO PAINTS	605
CELERY DISEASE INVESTIGATIONS	608
HORSE-RADISH ROOT ROT INVESTIGATIONS	610

Report of the Department of Plant Pathology

M. T. Cook

INTRODUCTION

The organization of the department has undergone very little change since our last report on June 30, 1919.

Dr. W. H. Martin, associate plant pathologist, devotes a considerable part of his time to the study of the diseases of potatoes. His work is discussed in a special report by him on pages 577-598.

C. M. Haenseler.continues with us as New Jersey Zinc Company fellow, and is getting some excellent results in his studies on fungi injurious to plants.

R. F. Poole, fellow in plant pathology, has been devoting the major part of his time to a study of the root rot of celery and the root rot of horseradish. On July 1 he will be placed in charge of the work on the diseases of sweet potatoes and tomatoes.

Miss Gertrude E. Macpherson's appointment expires with the end of this fiscal year. She presented her thesis on "Comparison of the Development of Dodder (*Cuscuta gronovii* Willd.) and Morning Glory (*Convolvulus repens* L.)," and received the degree of Master of Science in June, 1920. She also devoted a considerable amount of time to assisting the writer in his studies on the effects of bordeaux and other mixtures on potato plants, and on the brown rot of the peach. In addition, she has proven a very efficient assistant in miscellaneous laboratory duties.

Two new graduate students will assume their duties July 1, 1920. They are Wm. D. Moore and G. W. Fant, both of the class of 1920 of Clemson College, South Carolina.

RESEARCH

The research work in progress involves the following problems:

Mel. T. Cook—

1. The influence of bordeaux and other spray mixtures on potatoes.
2. Influence of mosaic and leaf roll on the yield of the potato.
3. The transmission of *sclerotinia cinerea* from year to year.
4. Causes of tomato fruit rots.
5. Removal of fruit tree cankers.

W. H. Martin—
1. Relation of sulfur to soil acidity and the control of potato scab.
2. Physiological studies of *Actinomyces scabies*.
3. Studies of physiological diseases of potatoes.
4. Relation of soil reaction to the growth of pathogenes.

C. M. Haenseler—
1. Fungi injurious to paints.
2. Spraying pears for the control of leaf and fruit spot.
3. Spraying cherries for the control of leaf spot.
4. Eggplant wilt.

R. F. Poole—
1. Root rot of celery.
2. Root rot of horseradish.
3. Control of diseases of sweet potatoes.
4. Control of the diseases of tomatoes.

The following publications have been issued from the department during the past year:

W. H. Martin. Relation of sulfur to soil acidity in the control of potato scab. *In* Soil Science, vol. 9, no. 6; June, 1920.
W. S. Krout. Common diseases of celery. New Jersey Agricultural Experiment Station. Circular 112.

Mr. Krout was formerly laboratory assistant and graduate student in the department and this circular is the result of studies made here. He is now connected with the Massachusetts Agricultural Experiment Station.

EPIDEMICS

The rainfall during the spring, summer and fall of 1919 was heavier than usual and the losses due to plant diseases much heavier than usual. Several diseases were severe enough to be listed as epidemics. They are as follows:

1. *The brown rot of the peach* was exceptionally severe in both 1919 and 1920. It is the subject for special study and is discussed more fully on page 572.
2. *The late blight of the potato* was exceptionally severe in 1919, especially on the late crop. A more complete discussion will be found on page 577.
3. *Potato scab* was more severe than usual in 1919. It is the subject of special study by Dr. W. H. Martin. His report on this subject will be found on pages 587-598.
4. *The root rot* of the pea was very severe throughout the southern part of the state in 1919. It was most destructive in Burlington County and was the cause of heavy losses. This disease occurs every year and always causes considerable loss, but in 1919 it was much more destructive than usual. It should be the subject of special study.
5. *Leaf fall* of many trees was especially severe during the spring and summer of 1919. The first complaints were concerning the beech of parks, streets and private estates, but later the complaints were made with reference to apple, peach and other trees. This entire subject is more fully discussed on pages 570-573.

6. *The leaf and fruit spot* of the pear and quince (*Fabrea maculata* (Lev.) Atk.) was exceptionally severe in 1919. Experimental work for the control of this is to be conducted by Mr. C. M. Haenseler.
7. *Stem cankers on tomatoes and cabbage* were reported from several points in the southern part of the state in 1919 and in some cases were the cause of heavy losses. The same disease was reported on peppers in 1920. It was due to *Rhizoctonia* and is primarily a seed-bed disease. Although this disease has been reported from other states, 1919 was the first year in which we have any record of its occurrence in this state.
8. *The stem rot of sweet potatoes* was no more severe than usual. It is always the cause of heavy losses and should have received attention long before this. Recent appropriations have made it possible to study this and other diseases of the sweet potato both in the field and in storage. R. F. Poole of this department has been assigned to this work, and will begin July 1, 1920.

OTHER IMPORTANT DISEASES

Because of the very wet season in 1919, a number of other diseases were of more than usual importance. They are as follows:

1. *Sun scald of the apple.* This injury was very severe throughout the greater part of the state, especially the southern half. It was due to the exceptionally high temperature on July 4 and 5. The part of the surface of the apple exposed to the direct rays of the sun became hard and black and in some exceptionally severe cases caused a cracking later in the season.
2. *Spray injury of the apple* was very severe in some orchards in which the concentrated lime-sulfur 1 to 40 was used. Self-boiled lime-sulfur used on trees of the same varieties in the same orchard gave excellent results and no injury.
3. *The black leg of cabbage* was very severe in localities in South Jersey. It is the opinion of the writer that a survey should be made to determine the severity of this disease, the amount of loss and the best methods for its control. Efforts for its control without this information are very likely to be misdirected. It is a problem for the trained plant pathologist.
4. *The root rot of celery* has been the subject of special study by W. S. Krout (formerly of this department) and by R. F. Poole. The trouble is due to two or possibly more organisms, and the symptoms are variable. It has been demonstrated that these organisms can be controlled by the proper seed-bed treatment but war conditions resulted in neglect on the part of many growers. This work is now ready for extension propaganda but the work should be carried on by a man trained in plant pathology who will be able to recognize the organisms and to overcome certain difficulties which are likely to arise.
5. *The root rot of corn* is a disease which is distributed throughout the state. It is especially severe in Salem County but occasionally causes considerable losses in other localities. We have been cooperating with the United States Department of Agriculture in the study of this disease. The records of this cooperation are appended to this report (pages 598-604). Because of the lack of funds the government support has been withdrawn but we are continuing the work.

6. *The root rot of horse-radish* is the cause of heavy losses in the northern part of the state especially in Passaic County. This has been the subject of study by Mr. Poole and is discussed on page 610 of this report.
7. *The leaf fall of the pepper* has been the cause of many complaints during the past three years. Thus far we have been unable to determine the cause of this disease but it results in rather heavy losses. It should receive careful consideration by a pathologist who can devote the necessary time to the work.
8. *The scab of wheat* causes a much greater loss than the growers realize. It is closely associated with the root rot of corn and should be studied in connection with that disease.
9. *The cherry leaf spot* was very severe, completely defoliating many trees and checking their growth before the close of the growing season. We are giving some attention to its control this year.
10. *The diseases of small fruits* are the cause of very heavy losses but are not generally recognized by the growers. A survey and brief study of these diseases followed by the proper extension propaganda would result in very great savings to the growers of small fruits.
11. *The melon and cucumber losses* due to diseases in 1919 were greater than usual. *Sclerotinia libertiana* Fckl., which is usually a serious disease on these crops when grown under glass, was quite severe in some fields. The control of some of these diseases would no doubt increase the melon and cucumber industry of the state.

COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE

A great deal of work of this department is very closely associated with the work of the New Jersey State Department of Agriculture.

1. *The inspection of nurseries* shows them to be in an exceptionally good condition so far as freedom from plant diseases is concerned. Our nurserymen do not handle the chestnut stock; a phase of the industry which was destroyed by the chestnut blight.
2. Very few of the common or European *barberries* are to be obtained in our nurseries, partly because of the quarantine restricting their shipment and partly because the Japanese barberry is a much more desirable plant for ornamental purposes.
3. *The blister rust on the white pine* has not been found in the state except in four nurseries. The blocks of trees in which it was found are under quarantine. The disease has been found on currants in two places, which also are quarantined.
4. It is impossible to inspect the nurseries for *crown gall and hairy root* but we have every reason to believe that very little if any of this disease goes out from the nurseries of the state. However, it is necessary to conduct very rigid inspections for this disease on stock coming into the state.
5. There has been some agitation in the state for an inspection of peach orchards in an effort to reduce *peach yellows and little peach.* The writer is inclined to believe that work of this kind cannot be carried on successfully at this time.
6. During the past year we began the inspection of *home-grown seed potatoes.* This work is very promising and a complete statement can be found in the reports of the State Department of Agriculture.

NEEDS OF THE DEPARTMENT

The force of workers in this department is not large enough to meet the many demands on us. The most urgent needs are as follows:

1. We need a well trained extension plant pathologist who can care for many calls which must now be cared for by those whose time should be given to research work. We wish to emphasize that the man in charge of this work should be a trained plant pathologist; a man who can recognize the diseases in their many variations, a man who can distinguish between diseases showing very similar symptoms although due to radically different causes, a man who can diagnose causes for failures in demonstrations and who recognizes the importance of environmental factors. Extension work on plant diseases by men not trained in plant pathology has resulted and will continue to result in more or less blunders and waste of public funds.
2. We need a man to conduct experimental work on strains resistant to diseases. This very important field is receiving a great deal of attention in the departments of plant pathology of many other agricultural experiment stations. Such a man should be well trained in plant pathology and should also have some knowledge of genetics. This is one of the most promising fields for research at the present time.
3. Many of our most important diseases are due to soil organisms. These forms are receiving a great deal of attention throughout the country. They present a number of very promising lines of study and we should give more attention to them.
4. The wilt diseases are becoming more and more important from year to year. They are usually due to soil organisms and should be studied by a well trained plant pathologist.
5. The mosaics and similar diseases (peach yellows, little peach, etc.) are very little nearer solution than they have been for many years past. They present very important and very difficult problems for research.
6. The diseases of grains and forage crops are causing much greater losses than we realize and should receive attention.
7. The diseases of small fruits are also taking heavy tolls and should receive attention or these industries will be greatly reduced within the next few years.
8. Many of the storage rots of fruits and vegetables, especially the sweet potato, are due to the same organisms that cause heavy losses in the field. They are of great economic importance and should be studied by well trained men.

THE HERBARIUM

The herbarium, which was at one time an exceptionally good collection of plants for study, has been neglected for many years. The mounted plants should be gone over very carefully and put in place and the large collection of unmounted plants should be mounted and carefully distributed so that they can be used. Prof. G. W. Martin has given some attention to this work during the past year but his time has been very limited.

DISEASES OF THE YEAR

Alfalfa

LEAF SPOT (*Pseudopeziza medicaginis* (Lib.) Sacc.). This disease was very severe but probably no more so than in previous years. The diseased leaves fall more readily than healthy leaves and the loss is quite heavy.

OTHER LEAF SPOTS due to various causes which have been recorded in previous reports were found occasionally but were of no importance.

ROOT ROTS were found and were no doubt the cause of some troubles.

Ampelopsis

LEAF SPOT (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was very prevalent, especially on the lower leaves of the plant. Other leaf spots were of no importance.

Apple

CROWN GALL AND HAIRY ROOT (*Pseudomonas tumefaciens* S. & T.). Common on the apple and many other plants. Sometimes the very evident cause of weak and short-lived trees.

BLACK ROT (*Sphæropsis malorum* Pk.). Very common but no more severe than usual.

BITTER ROT (*Glomerella rufomaculans* (Berk.) S. & van S.). More severe than usual.

BLOSSOM END ROT (*Alternaria sp.*). Very common but not serious.

JONATHAN SPOT (*Alternaria sp.*). Very abundant.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Less severe than for several years but very destructive in some few orchards.

BLOTCH (*Phyllosticta solitaria* E. & E.). More severe than usual. Most common on the Smith Cider.

SOOTY BLOTCH (*Phyllachora pomigena* (Schu.) Sacc.). Common in neglected orchards.

SCAB (*Venturia inequalis* (Cooke) Wint.). Common, especially in unsprayed orchards.

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very severe in a few localities.

PINK ROT (*Cephalothecium roseum* Cda.). Common but of little importance.

FRUIT SPOT (*Cylindrosporium pomi* Brooks). Occasional.

STIPPEN (?). Very common.

WINTER INJURY. Very common.

SPRAY INJURY. Very common when concentrated lime-sulfur 1 to 40 was used (page 571).

WATER CORE (?). Occasional.

SUN-SCALD. Very common; due to exceptionally hot weather during July 4 and 5, 1919 (page 559).

Asparagus

RUST (*Puccinia asparagi* D. C.). Occasional.

DWARFING. Short, weak shoots in the early spring. *Fusarium sp.* always present but we are not certain that it was the cause of the disease.

Asters

YELLOWS (cause unknown). This is a disease more or less prevalent every year.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* Sacc. & Magn.) (Bri. & Cav.). Prevalent throughout the state and destructive.

LEAF AND POD SPOTS (*Diaporthe phaseolorum* (C. & E.) Sacc.). Prevalent, especially in the southern part of the state, but not very destructive.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Very abundant and severe throughout the state.

ROOT ROT (*Rhizoctonia*). Very common.

RUST (*Uromyces appendiculatus* (Pers.) Lev.). Rare.

BACTERIAL BLIGHT (*Pseudomonas phaseoli* E. F. Smith). Occasional early in the season. Of no importance.

Beech

BURNING of the foliage early in the summer as a result of the low temperature in the early spring. Especially severe in the northern third of the state (page 570).

Beets

LEAF SPOT (*Cercospora beticola* Sacc.). Very abundant but not considered of any importance.

SCAB (*Actinomyces chromogens* Gast.). Very severe and destructive in one locality.

Blackberry

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common but of relatively little importance.

LEAF SPOT (*Septoria rubi* West.). Common but of very little importance.

RUST (*Gymnoconia peckiana* (Howe) Tranz.). Common and sometimes destructive.

(See Dewberry and Raspberry.)

Cabbage, Cauliflower and Kohlrabi

BLACK LEG (*Phona lingam* (Tode) Desmaz.). Prevalent in the southern part of the state and very severe in Camden County.

YELLOWS (*Fusarium conglutinans* Wollenw.). Common and widely distributed throughout the state but not severe.

BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Occasional.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). Occasional. Sometimes very destructive.

STEM ROT (*Rhizoctonia*). One record (page 559).

Cantaloupe

(See Muskmelon)

Carnation

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

Catalpa

LEAF SPOT (*Phyllosticta catalpæ* Ell. & Mart.). Common and sometimes the cause of heavy leaf-fall.

Cedar

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very abundant in restricted localities throughout the state. Reported from Monmouth, Burlington and Cape May counties.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Abundant in the celery-growing districts throughout the state.

LATE BLIGHT (*Septoria petroselini* Desm.. var. *apii* Br. & Car.). Abundant in the celery-growing districts throughout the state.

ROOT ROT (*Sclerotinia libertiana* Fuckel). Occasional, sometimes severe.

CROWN AND HEART ROTS (*Bacterial*). Very severe in some localities (page 608).

Cherry

BROWN ROT (*Sclerotinia cinerea* (Bon) Shrot.). Abundant and very destructive.

LEAF SPOT (*Cylindrosporium padi* Karst.). Abundant and destructive (page 673).

Chestnut

BLIGHT (*Diaporthe parasitica* Murrell). Abundant.

Clover, Red

RUST (*Uromyces trifolii* (Hedw.) Lev.). Common but of no importance.

Corn

SMUT (*Ustilago zeae* (Beckm.) Urg.). Very common and in some cases serious.

WILT (*Fusarium* (?). Widely distributed throughout the state but most severe in Salem County (page 598).

WILT (*Pseudomonas stewarti* E. Smith). Occasional in the northern part of the state. Of no importance.

RUST (*Puccinia sorghii* Schw.). Occasional but of no importance.

LEAF BLOTCH (*Helminthosporium inconspicuum* C. & E.). Common.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Common.

Cranberry

SCALD (*Guignardia vaccinii* Shear.). Widely distributed and very abundant in the cranberry bogs of the state.

ROT (*Acanthorhynchus vaccinii* Shear.). More or less common.

ANTHRACNOSE (*Glomerella rufomaculans vaccinii* Shear.). *Gloeosporium* stage common.

Cucumbers

LEAF SPOT (*Macrosporium cucumerinum* C. & E.). Common and destructive.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and destructive.

WILT (*Bacillus tracheiphilus* Edw. Smith). Very common.

STEM ROT (*Sclerotinia libertiana* Fckl.). Occasionally found in the field. Probably due to the wet season.

Currant

ANTHRACNOSE (*Gloeosporium ribis* (Lib.) M. & D.). Very common.

LEAF SPOT (*Septoria ribis* Desm.). Common.

CANE BLIGHT (*Botryosphæria ribis* G. & D.). Common and very destructive.

RUST (*Cronartium ribicola* Kleb.). Reported from two localities (page 560).

Dewberry

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Common and sometimes severe.

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). Abundant and sometimes injurious.

RUST (*Gymnoconia peckiana* (Howe) Franz.). Common and sometimes destructive.

LEAF SPOT (*Septoria rubi* West.). Very abundant but of little importance.

Eggplant

LEAF BLIGHT (*Phomopsis vexans* (Sacc. & Syd.) Harter). Abundant and in some cases destructive.

WILT (*Verticillium albo-atrum* R. & B.). Common and destructive throughout the state.

Gooseberry

ANTRCACNOSE (*Pseudopeziza ribis* Kleb.). *Gloeosporium* stage common.

LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* (Ell.) V. & R.). Abundant and severe.

DOWNY MILDEW (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.
NECROSIS (*Fusicoccum viticolum* Reddick). Rare.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common.

Horse Chestnut

LEAF SPOT (*Guignardia æsculi* Stewart). Very common.

Horse-Radish

ROT ROT (*Bacterial*). Very common and very destructive in one locality (page 610).
ROOT ROT (*Thielavia basicola* (B. & Br.) Zoph.). Very common in one locality (page 610).

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common and sometimes destructive.
ROTS (*Bacterium marginale* Brown and *B. vitians*). Reported from one locality.

Lilac

MILDEW (*Microsphæra alni* (Walls.) Wint.). Very common.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Common.

Maple

TAR SPOT (*Rhytisma acerinum* (Pers). Fr.). Occasional.
LEAF SCALD (page 570).

Muskmelon

WILT (*Bacillus tracheiplilus* (E. Smith). Common and sometimes destructive.
DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and sometimes severe.
LEAF MOULD (*Alternaria brassicæ* (Berk.) Sacc. var. *nigrescens* Pegl.). Common and severe.

Oak

ANTHRACNOSE (*Gnomonia veneta* (Sacc. & Speg.) Kleb.). Common.
LEAF CURL (*Taphrina cærulescens* (Mont. & Desm.) Tul.). Common and the subject of a number of inquiries.

Oats

SMUT (*Ustilago levis* (K. & S.) Magnus). Common.
SMUT (*Ustilago avenæ* (Pers.) Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.

Okra

WILT (*Verticillium albo-atrum* R. & B.). Abundant in one locality.

Pea

LEAF SPOT (*Ascocchyta pisi* Lib.). Occasional.
ROOT ROT (*Fusarium sp.*). Very abundant and very destructive. Heaviest losses in Burlington County (page 558).

Peach

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Abundant and destructive (page 572).
SCAB (*Cladosporium carpophilum* Thüm.). Abundant in unsprayed orchards. More destructive to foliage than usual (page 572).
LEAF CURL (*Exoascus deformans* (Berk.) Fckl.). Abundant in orchards that have not been properly sprayed.
SHOT HOLE (*Bacterium pruni* E. Smith). Abundant in some localities.
YELLOWS. Common.
LITTLE PEACH. Common.
CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Common.
WINTER INJURY. In some cases severe and dating back to 1917-18.

Pear

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni.). Common throughout the state and severe in a few orchards.
LEAF AND FRUIT SPOT (*Fabrea maculata* Lev.). Very abundant and very destructive in some orchards, especially in the southern part of the state.
LEAF SPOT (*Septoria pyricola* Desm.). Abundant.
BROWN BLOTCH (cause undetermined). Common.
SCAB (*Venturia pyrina* Aderh.). Common where the orchards have been neglected.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common.
ROT (*Macrosporium sp.*). Common on fruits, especially those that have been sunburned.
MOSAIC. Common but apparently of little importance.
SUN SCALD. Common and followed by fruit rots.
LEAF FALL (cause unknown). Cause of heavy losses.

Pine

BLISTER RUST of white pine (page 560).
DIE-BACK (*Diplodia sp.*). Very destructive on Austrian pine.

Plum

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thüm.). Common throughout the state.
BROWN ROT (*Sclerotinia cinerea* (Bon.) Wor.). Common throughout the state and destructive.

Poplar

LEAF SPOT (*Marsonia populi* (Lib.) Sacc.). Common.
CANKER (*Dothichiza populae* S. & B.). Occasional and of some importance.

Potato

BROWN STEM (*Rhizoctonia*). Common but not as destructive as in previous years.
BLACK LEG (*Bacillus phytopthorus* Appel). Rare.
SCAB (*Actimonyces chromogenus* Gast.). Much more abundant than usual (page 587).
EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). Abundant throughout the state (page 577).
LATE BLIGHT (*Phytophthora infestans* DeBarry). Very abundant and very destructive (page 577).
MOSAIC. Very severe in some fields of Giants.
LEAF ROLL. Rare; not found to exceed 2 per cent in any case.
TIP BURN. Common but less than usual.
ARSENICAL POISONING. Common and usually due to carelessness in application.
SPINDLING SPROUTS. Common. Probably due to several causes.

Quince

BLACK ROT (*Sphaeropsis malorum* Pk.). Very abundant and very severe.
FIRE BLIGHT (*Bacillus amylovorus* (Burr.) De Toni). Common.
LEAF AND FRUIT SPOT (*Fabrea maculata* (Lev.) Atk.). Abundant and very severe.
RUST (*Rostellia anrentiana* Pk.). Occasional.

Raspberry

ANTHRACNOSE (*Gloeosporium venetum* Speg.). Abundant and destructive.
LEAF SPOT (*Septoria rubi* West.). Abundant but of little importance.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common and sometimes destructive.
CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Abundant and destructive.

Rose

ANTHRACNOSE (*Gloeosporium rosae* Hals.). Common but not serious.
LEAF BLOTCH (*Actinonema rosae* (Lib.) Fr.). Common and very severe in greenhouses.
LEAF SPOT (*Phyllosticta rosicola* Massal.). Abundant and sometimes confused with leaf blotch.
CANE BLIGHT (*Coniothyrium fuckelii* Sacc.). Common and sometimes serious.
POWDERY MILDEW (*Sphaerotheca pannosa* (Wallr.) Lev.). Common and frequently very injurious.
CROWN GALL (*Pseudomonas tumefaciens* S. & T.). Frequent and sometimes serious.

Spinach

MOSAIC. Serious. Complicated with attacks of plant lice.

Strawberry

LEAF SPOT (*Mycosphaerella fragariae* (Tul.) Lidau). Common.
LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.
POWDERY MILDEW (*Oidium fragariæ* Harz.). Occasional.
WINTER INJURY. Occasional.

Sunflower

RUST (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

BLACK ROT (*Sphaeronema fimbriatum* (E. & H.) Sacc.). Abundant and the cause of heavy losses (page 557).
STEM ROT or YELLOW ROT (*Fusarium batatatis* Wollen. and *F. Hyperoxysporum*). Abundant and the cause of heavy losses (page 557).
SCURF (*Monilochaetes infuscans* E. & H.). Very common.
ROTS (*Rhizopus nigricans* Ehr., *Diaporthe batatatis* H. & F., *Scleroticum bataticola* Tamb., *Tricoderma koenigii* and *Penicillium* sp.). Very abundant, especially in storage.
POX (*Cytospora batata*). Occasional.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* (S. & S.) Kleb.). Very common. Sometimes destructive in nurseries.

Tomatoes

LEAF BLIGHT (*Septoria lycopersici* Speg.). Abundant and very destructive
FRUIT ROT (*Macrosporium solani* E. & M.). Common and very destructive.

ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). Abundant and very destructive.
STEM BLIGHT or WILT (*Fusarium lycopersici* Sacc.). Abundant in one locality.
STEM CANKERS (*Rhizoctonia*). Abundant in lower part of the state (page 559).
MOSAIC. Abundant.
LEAF MOLD (*Cladosporium fulvum* Che.). Common in greenhouses and very severe.
LATE BLIGHT (*Phytophthora infestans* DeBary). Severe in one locality.
SUN BURN. Severe at times. Followed by fruit rots.

Walnut

LEAF SPOT (*Marsonia juglandis* (Lib.) Sacc.). Abundant and cause of early fall of foliage. Subject of many inquiries.
BACTERIAL SPOT OF LEAF AND FRUIT (*Pseudomonas juglandis* Pierce). Abundant on English walnuts and the cause of many inquiries.

Watermelons

ANTHRACNOSE (*Colletotrichum lagenarium* (Passe.) E. & H.). Very abundant.
STEM ROT (*Sclerotinia libertiana*). Common in the fields. Probably the result of wet weather.

Wheat

RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia rubigovera* (De C.) Wint.). Common.
RUST (*Puccinia triticina* Erb.). Common.
SMUT (*Tilletia foetens* (B. & C.) Trel.). Common.
SMUT (*Tilletia tritici* (Bei.) Wint.). Common.
SMUT (*Ustilago tritici* (Pers.) Jens.). Common.
MOLD (*Cladosporium herbarium* (Pers.) Lk.). Abundant.
SCAB (*Gibberella saubinetti* (Mont.) Sacc.). Very common and destructive.

Forest and Shade Trees

LEAF FALL (pages 570-571).

FALLING FOLIAGE

MEL. T. COOK

The spring and summer of 1919 were notable in New Jersey because of the enormous amount of falling foliage and the susceptibility of many trees to spray injury. In fact, spray mixtures which had been very generally recommended and used in the past resulted in more or less injury to both foliage and fruit.

The first complaints coming to the Experiment Station was concerning the dying and falling of foliage of the beech and the apple.

All of the complaints concerning the beech and most of those concerning the apple were from the northern third of the state.

The writer visited the Essex County parks, and some of the private estates, and also examined many specimens which were submitted to him. The beech leaves showed a peculiar burning or drying along the margins and frequently between the veins. In severe cases the leaves fell in great numbers. Many of the trees suffered a very severe attack, some of them losing great quantities of foliage while others showed very little burning.

A careful study of the conditions convinced the writer that the trouble was entirely due to a period of low temperature soon after the leaf buds opened and before they were fully developed. At this particular time the protoplasmic activity was high and the cuticle not fully developed. Therefore, the leaves continued to grow to some extent and the dying of the injured cells was a slow process. The effects of this low temperature extended over a period of about six weeks. The variation in the amount of injury was dependent on the advancement of the leaves at the time of the low temperature, to the location of the trees and to the exposure.

The dying of apple leaves was not so definite as the dying of the beech leaves but practically all of the injured leaves fell. Repeated examinations failed to reveal a fungus or any cause of the trouble other than the cold weather. Only the leaves that were coming out at the time of this low temperature showed injury. The latter leaves were not injured.

These conditions should not be confused with sun scald and drought injuries which are more or less common on many trees later in the season.

Weak Trees

Trees, more especially the peach, which were weakened as a result of winter injury in 1917-18, by borers, or for want of food lost considerable foliage during the latter part of June and first part of July.

Spray Injury

Spray injury was more frequent than in past years; many mixtures causing injuries which had not given trouble in past years. Among the most important were summer-strength lime-sulfur and atomic sulfur. Arsenical burnings were also quite frequent. The self-boiled lime-sulfur did not cause burnings and gave good control in both peach and apple orchards.

Paris Green Injury

The falling of foliage in some orchards was very readily traced to paris green dust which had drifted in from the adjoining potato

fields. In these cases the injury was always most severe on the rows next to the potato field and less severe on the succeeding rows.

Brown Rot of the Peach

During the blooming period of the peach in 1919 there was an exceptionally severe outbreak of the twig and blossom blight caused by the brown rot organism (*S. cinerea*). This outbreak was most severe in the vicinity of Vineland and Bridgeton and was of very little importance in the northern part of the state. This was by far the most severe outbreak of this disease that the writer has ever observed. It was not abundant on the young shoots but destroyed great quantities of blossoms. In the majority of cases a sufficient number of blossoms remained for a normal crop, the problem being to protect those that did remain from curculio and other pests.

Many growers sprayed with self-boiled lime-sulfur or atomic sulfur at this time. It is doubtful if this checked the disease on the blossoms, although it did prevent the spread to the new wood, as will be explained later.

The blossom blight form did not persist, but was followed by a spreading into the wood and the formation of cankers in most cases where blossoms were killed. These cankers produced an abundance of gum which in some cases continued to flow until some time in August.

The blossom blight was followed by the formation of cankers at the nodes on the new growth, always beginning with basal node and gradually working toward the tip and rarely missing a node. The first evidence of the canker is the dying of the bud, followed by the falling of the leaf and then the formation of the canker. The older cankers at the base of the shoots sometimes form a girdle and cause the death of the entire new growth. In many cases cankers were formed at every node for fully two-thirds the new growth. This is one of the most important causes of the falling of the foliage during July. In some orchards 75 per cent of the new buds were killed. In the well-sprayed orchards very few cankers were formed on the new growth.

Peach Scab

Peach scab came into prominence on the fruit in July and became quite common in well-sprayed orchards in the latter part of the month. In the early part of July this disease also appeared on the leaves and increased in abundance. The symptoms were first a reddening of the foliage followed by shot hole and then by falling. This was one of the most important causes of the falling of the foliage.

Cherry Leaf Spot

This disease was very abundant and by the latter part of July many trees were almost completely defoliated.

It can be controlled by two sprayings with self-boiled lime-sulfur; first with the shuck-fall (add an arsenical), and second after picking the fruit. A third spray would be advantageous.

FIELD STUDIES ON POTATO DISEASES

MEL. T. COOK

During the past eight years the writer has been giving considerable time to a study of the diseases of potatoes. The most important diseases considered during this time are: (1) black leg, (2) powdery scab, (3) common scab, (4) *Rhizoctonia,* (5) early blight, (6) late blight, (7) dry rot, (8) weather injury, (9) mosaic and (10) leaf roll. A brief resumé of the work will be given in this paper.

(1) BLACK LEG is a bacterial disease (*Bacillus phytopthorus* Appel) which was very severe and destructive a few years ago, sometimes causing a loss of 15 per cent. This disease is very rare at the present time. It is very easily recognized and the certification work is no doubt largely responsible for its removal from the growing crops in the northern seed-producing districts. Diseased plants die very early under New Jersey conditions and rarely produce seed tubers; therefore, the growing of late-crop seed tends to eliminate it.

(2) POWDERY SCAB, which is said to be a very serious disease in Europe, was introduced into Canada, Maine and New York a few years ago. Planting diseased seed in experiments under our supervision did not produce the disease on the new crop. This was corroborated by experiments in other states.

(3) COMMON SCAB is a well-known disease which was the subject of three years' work by Dr. H. Clay Lint, formerly of this department. His work is recorded in the Annual Reports for 1914, 1915 and 1916, and in Circular 95. Work on this disease was resumed in 1919 by Dr. W. H. Martin (pages 587-598).

(4) SCURF OR RHIZOCTONIA is a very injurious disease which varies in severity from year to year. It is very generally known in New Jersey by the name of "brown stem." The black sclerotia are visible on the tubers which may be smooth and apparently normal in every way, or may be small and irregular in shape, or, in extreme cases, may have very much the same general appearance as common scab. The organism can be carried on the seed and will also persist in the soil and will attack many other plants. Our experimental work[2] shows

[2] Part of the material used in these experiments was collected in New Jersey and part sent us by Dr. W. J. Morse, of the Maine Agricultural Experiment Station.

that the amount of infection on the seed tubers is no index of the severity of the disease in the field. The severity of the disease on the growing crop varies with the character of the soil, and probably with the temperature and the moisture.

The results of an experiment on seed treatment for the control of this disease are given in table 1.

TABLE 1

Results of Seed Treatment to Control Disease—Experiment 1

Row No.	Condition	Treatment	Condition of crop	Total yield, lbs.	Yield per row, lbs.	Firsts per cent	Seconds per cent
6, 7, 8, 9	Sclerotia abundant	Untreated	Very few Sclerotia	90.0	22.5	50.0	29.9
10, 11	Sclerotia abundant	Corrosive Sublimate	Clean	101.3	50.6	83.3	13.9
12, 13	Sclerotia abundant	Formalde-hyde	Clean	70.0	35.0	71.0	20.0
22, 23	Sclerotia abundant Deep pits	Untreated	Few Sclerotia	75.6	37.8	77.0	16.3

The results of a second experiment are given in table 2.

The results of these experiments indicate that corrosive sublimate gives much better results than formaldehyde.

(5) EARLY BLIGHT (*Macrosporium solani* (E. & M.) J. &. G.) is a very common disease on both potatoes and tomatoes. The organism is both parasitic and saprophytic and is very frequently found growing on parts of plants injured by tip-burn, arsenical poisons or other factors. The disease can frequently be controlled by spraying with bordeaux mixture and can usually be delayed by this treatment.

(6) LATE BLIGHT (*Phytophthora infestans* DeBy) is one of the most important diseases of the potato in America. It attacks both the foliage and the tuber, causing the well-known mahogany rot on the latter. More or less of this disease comes into New Jersey on the northern seed every year but rarely develops on the growing

plants. In 1918 there was an outbreak throughout Mercer and Monmouth counties, and the southern half of Middlesex, but the losses were not serious. In 1919 there was a very severe outbreak throughout practically the entire state beginning the latter part of July, and gradually becoming more and more severe throughout the growing season. The losses in the early or main crop due to this disease were very slight, but the losses in the late crop grown principally for seed were very heavy. The losses in the first crop during the

TABLE 2

Results of Seed Treatment to Control Disease—Experiment II

Plots	Hill	Character of seed	Treatment	Number of Firsts	Weight of Firsts	Number of Seconds	Weight of Seconds	Total
					lbs.		lbs.	lbs.
4	1-38	Sclerotia abundant many deep pits	None	109	36.67	237	16.04	51.71
5	1-38		Corrosive Sublimate	144	49.7	138	11.29	60.99
6	1-38		Corrosive Sublimate	163	56.66	156	13.87	70.53
7	1-38		None	120	40	247	22.91	66.91
8	1-38		Formaldehyde	100	33.41	216	17.83	51.24
9	1-38		Formaldehyde	147	48.63	208	14.01	62.64
10	1-38		None	116	40.49	310	19.57	60.06

last few days of July and the early part of August were complicated by the losses due to bacterial rots. Undoubtedly the greater part of these early losses were due to the bacterial rot. The Federal market inspectors found late blight rot in some of the early shipments from New Jersey, but were misled as to the amount due to this cause and the amount due to bacteria. The losses due to bacteria were very heavy in many fields in which there was no late blight. The loss due to bacteria was 90 per cent in some of the experimental plots on the Experiment Station farm in which there was no late blight. The results of the potato spraying experiments by Dr. W. H. Martin are given on pages 577-587.

(7) DRY ROT (*Fusarium oxysporum* Schlt.) is to be found every year and occasionally causes losses, but cannot be considered as one of our most important diseases. The writer has made numerous tests by planting the sound parts of potatoes partly rotted by this and other organisms. In the majority of cases the plants were weak as compared with those grown from sound tubers.

(8) WEATHER INJURIES are more or less common. One of the most important forms of weather injury is "tip-burn." It is most severe during hot weather following a wet season.

(9) MOSAIC is one of the most severe diseases on the American Giant. It is also very severe on Green Mountains and Bliss Triumphs, but these varieties are not used so abundantly in this state. Experimental tests covering a period of 5 years reveal the following facts: (1) The disease is transmitted in the tubers; (2) it reduces the yield, and (3) it increases in severity from year to year.

A few of the characteristic results of experimental work on this disease are discussed below.

Green Mountain potatoes from Maine, sent to us by Dr. W. A. Orton, of the United States Department of Agriculture, gave the following results in 1916:

Plot	Seed	Crop	Firsts	Seconds	Total yield per acre
			per cent	per cent	bushels
1	Healthy	Fine	86.10	12.80	429
2	Mosaic	52.6 per cent Mosaic	60.88	13.12	329
3	Mosaic	Severe Mosaic	66.27	33.72	169+
4	Mosaic	Mosaic	74.29	24.27	335

A study of this table shows that plants affected with Mosaic gave a lower yield than the healthy plants. The disease is not so easily detected on the Green Mountains as on the American Giants. The more prominent the disease on the foliage, the less is the yield.

The 1917 experiments were conducted with Bliss Triumphs. The seed was obtained from Maine through the United States Bureau of Plant Industry and the results are as follows:

Plot	Character	Yield per acre
1	Mosaic	73 bushels
2	Healthy	98 bushels

In 1919 tests were made with American Giants, using seed selected by the writer from the New Jersey 1918 late crop. The results were as follows:

Plot	Firsts	Seconds	Yield per acre firsts and seconds	Character
	per cent	per cent	bushels	
1	71.87	28.12	117	Mosaic
2	76.54	23.45	89	Mosaic
3	83.72	16.28	157	Healthy
4	69.80	30.2	300	

(10) LEAF ROLL of the Irish Cobblers is a very serious disease which varies greatly from year to year. Repeated experiments have demonstrated that it reduces the yield. The results in 1919 with Maine seed furnished by the United States Bureau of Plant Industry, Laboratory for Cotton, Truck and Forage-Crop Disease Investigations, gave the following results:

Plot	Character	Firsts	Seconds	Yield per acre firsts and seconds
		per cent	per cent	bushels
1	Leaf roll	25.78	74.22	57
2	Leaf roll	43.9	56.1	69
3	Healthy	53.0	47.10	132
4	Healthy	60.8	39.2	144

REPORT OF POTATO SPRAYING TESTS

WM. H. MARTIN

Cooperative potato spraying experiments were conducted by the department of plant pathology during the summer of 1919. The general plans followed in these experiments were similar to those

followed in experiments by the department during the past seven years.

In the period over which this work was carried on, twelve spraying experiments have been conducted with main-crop Cobblers; of these, eight gave positive results and four negative. The increase from spraying has not been marked, however. The average yield of the plots sprayed with bordeaux-arsenate of lead was 266.6 bushels, while the average for plots sprayed with arsenate of lead was 261.0 bushels. Spraying experiments with late-crop Cobblers were conducted three years. This crop is planted about August first and is used for seed the following year. On account of the late planting date, the crop grows under conditions similar to those of the northern potato-growing sections. The average yield of the sprayed plots was 209.3 bushels per acre, and the yield of the check plots was 199.0 bushels. Experiments with the American Giant variety were conducted for three years. The average yield for the plots sprayed with bordeaux was 354.6 bushels, and the yield of the check plots sprayed with arsenate of lead was 354.3 bushels per acre.

In the period over which these experiments were conducted the only foliage diseases which appeared were tip-burn and early blight. Considerable late blight was reported in various parts of the state in 1918, but none appeared in the fields in which the spraying experiments were conducted. The absence of late blight may account for the fact that only slight increases resulted from spraying.

This year two experiments were conducted with the main crop, one with Irish Cobblers and the other with American Giants. There was no late blight in the fields in which this work was done. One experiment was conducted with the late-planted Cobblers. This year there was a serious outbreak of late blight on this crop, the first time the disease has been reported from the section in which this work was done since 1897. At that time Dr. Halsted reported that scarcely a leaf escaped attack. As a result of the presence of this fungus in the field marked results were obtained. The vines on the sprayed plots were green for some time after the unsprayed vines were dead. The difference between the plots is clearly shown in plate 5.

Spraying Test in Cooperation with J. Harry Kandle, Elmer, N. J.

The soil on which this test was conducted is a Sassafras loam to sandy loam in excellent condition and well adapted to potatoes.

The field was planted with home-grown Irish Cobblers. One ton of a 4-8-3 fertilizer per acre was applied at the time of planting. The field was divided into 10 plots each 8 rows wide. To eliminate differences that might arise from soil variation a check plot was alternated with every two treated plots. Each treatment with the check

was repeated three times. The check plots were sprayed with arsenate of lead at the rate of 3 pounds to 50 gallons of water.

The following spray mixtures were used: home-made bordeaux mixture of the standard 5-5-50 formula and a zinc bordeaux furnished by the General Chemical Company, of New York. The proprietary mixture was used at the rate of 16½ pounds to 100 gallons of water, this being equivalent in the amount of metallic copper to the home-made mixture.

The sprays were applied with a traction sprayer that developed 150 pounds pressure. This machine was entirely satisfactory and it is questionable if higher pressure would give better results. For the first application two nozzles were used to the row, for subsequent ones an additional nozzle was used. One nozzle was pointed downward while the other two were directed inward so that the lower leaf-surfaces were covered with a film of the mixture.

Five spray applications were made on each of the different treatments. The first application was made May 31, when the plants were about 6 inches high. At the time of the second application, June 10, the plants were 18 inches high and were still free from disease. The third and fourth applications were made June 17 and 27, respectively. On the latter date, there was considerable early blight and tip-burn on the check plots with smaller amounts on the sprayed plots. The last application was made July 7; at that time, there was a decided contrast between the sprayed and the unsprayed plots. The plots were free from potato beetles at all times during the summer. Large numbers of flea beetles were present during the early summer and the copper mixtures did not appear to repel them to any marked extent.

On July 22 an examination of all the plots was made to determine the per cent of dead leaves on the different plots. It was impossible to do this for every plant, so observations were made on every tenth plant in the central row of each plot.

In table 1 is given the per cent of dead leaves for each plot as well as the average for each treatment.

The dying of the leaves may be ascribed for the most part to a heavy infestation of early blight and to tip-burn. It will be noticed that the plots sprayed with the commercial mixture had fewer dead leaves than those sprayed with home-mixed bordeaux. In this connection, it is interesting to note that two weeks before these observations were made, the plots sprayed with the home-made mixture had fewer dead leaves than the other plots. The marked differences in the number of dead leaves are due to the control of early blight and tip-burn. In a spraying experiment conducted on this field in 1915 by Dr. H. C. Lint, a similar contrast was obtained. From the time the differences were noticed until the potatoes were dug there was dry weather. This may account for the fact that there was no increase in yield at that time. This year, after the contrast between the check and the sprayed plots had appeared there was a week

TABLE 1

Per Cent of Dead Leaves on Each Plot and the Average for Each Treatment

Treatment	Dead Leaves			
	Series 1	Series 2	Series 3	Average
	per cent	per cent	per cent	per cent
Check	98	98	90	89
Bordeaux 5-5-50	45	45	40	44
Zinc-bordeaux	40	20	20	27

TABLE 2

Arrangement of Plots and Yield Per Acre in the Spraying Experiment With Main-Crop Cobblers

	Total Yield per acre			Yield of Firsts per acre			Yield of Seconds per acre		
	All plots	Calculated check		All plots	Calculated check	Difference due to spray	All plots	Calculated check	Difference due to spray
	bu.	bu.	per cent	bu.	bu.	bu.	bu.	bu.	bu.
Check	202.9	.....	.....	176.1	.....	.....	26.8	.....	.....
Bordeaux mixture	261.3	201.8	77.4	227.0	175.9	51.1	34.3	26.1	8.2
Zinc-bordeaux	253.5	200.9	79.2	212.6	175.6	37.0	40.9	25.4	15.5
Check	200.0	.....	.....	175.3	.....	.....	24.7	.....	.....
Bordeaux mixture	270.2	212.5	78.6	239.1	183.0	56.1	31.1	29.5	1.6
Zinc-bordeaux	275.1	225.0	81.7	232.2	190.7	41.5	42.9	34.3	8.6
Check	237.5	.....	.....	198.6	.....	.....	39.0	.....	.....
Bordeaux mixture	264.6	232.9	88.0	232.5	196.2	36.3	32.1	36.6	—4.5
Zinc-bordeaux	277.3	228.2	82.2	241.3	193.9	47.4	36.4	34.3	2.1
Check	223.6	.....	.....	191.6	.....	.....	32.0	.....	.....
Average	Bordeaux		+18.7	Bordeaux		+47.8	Bordeaux		+1.8
	Zinc-bordeaux		+19.3	Zinc-bordeaux		+41.9	Zinc-bordeaux		+8.7

of wet weather. As a result of this the sprayed plants, being still green, continued their growth. This may explain the fact that an increase in yield followed the spray applications this year.

The arrangement of the plots and the yield per acre for each plot are given in table 2.

To obtain a more accurate measure of the influence of the different spray treatments on yield the "calculated yield" for each sprayed plot has been computed on the basis of the yields from the adjoining check plots. The difference between the calculated yield of a plot and the actual yield has been taken as the difference due to the spray treatment.

It will be seen from the table that there was very little difference between the yields from the plots treated with the two spray mixtures. On a basis of total yields, the average increase over the check for the home-made bordeaux mixture was 49.6 bushels, while the commercial mixture gave an increase of 50.6 bushels over the adjoining checks.

Spraying Test in Cooperation with Theron McCampbell, Holmdel, N. J.

Conflicting results have been obtained in the past from spraying experiments with the American Giant variety. Of the three experiments, two gave an increase of 3 and 8 bushels per acre, respectively, while the third gave a decrease of 10 bushels per acre. This year an experiment with this variety was conducted in one of the best potato growing sections of the state. The field in which the work was done was planted with the Irish Cobbler variety in 1918. The vines did not make their growth and a poor crop resulted. Numerous reports have come to the Experiment Station of the failure of potatoes following alfalfa. In this connection, it is interesting to consider the crop history of this field for the past seven years:

1913-17—Alfalfa, 15 crops removed.
1918—5 carloads of New York horse manure added in early winter.
1918—Planted in Cobblers. Vines stunted, only about half a crop. After the crop was dug 500 pounds of 4-8-0 fertilizer per acre was broadcasted, and the field planted in wheat.
1919—500 pounds steamed bone added before the wheat was turned under. American Giant variety planted; 1500 pounds of a 4-8-3 fertilizer applied at time of planting.

This year there was a good stand and the vines made a good growth. It is doubtful if the soil condition had any marked influence on the results obtained from the spraying experiment.

The spray mixtures used were calcium arsenate, arsenate of lead, paris green and bordeaux mixture. The arsenate of lead was used

at the rate of 3 pounds of the powder to 50 gallons of water; the other insecticides were used in such proportions as to give equivalent amounts of metallic arsenic in every case. The insecticides were added in the experiment to determine the relative efficiency of the various sources of arsenic. This phase of the work was under the direction of the department of entomology of the station. The bordeaux mixture used was of the 5-5-50 formula, containing 3 pounds of arsenate of lead. The sprays were applied with a power sprayer that developed 250 pounds' pressure. As the field was laid out there were 25 plots, each 8 rows wide. A check plot alternated with each two treated plots. The check plots, nine in all, were sprayed with arsenate of lead. The paris green and calcium arsenate plots were repeated four times and the bordeaux plots eight times.

Table 3 records the dates on which the spray applications were made, as well as the insects and diseases present in the field at the time.

TABLE 3

Conditions of the Spray Applications

Plots	Date of Application	Insects Present	Diseases Present
5-11-17-23	May 16	Flea beetles	No foliage disease
All plots	May 27	Flea beetles	No foliage disease
All plots	June 5	Flea beetles	Some tip-burn
All plots	June 12	None	Tip-burn and early blight
All plots	June 20	None	Tip-burn and early blight

Prior to June 20 there were no noticeable differences between the different plots. After that date, the plots sprayed with paris green became heavily infested with early blight while the remaining plots were only slightly infested. Later in the summer the plots sprayed with arsenate of lead were decidedly better than those sprayed with bordeaux mixture. At first thought, this would appear to be due to the use of an improperly prepared bordeaux mixture. This explanation will not suffice, however, since plants under fertilizer and variety tests in adjoining fields were sprayed with the same mixture and on the sames dates. These vines remained green for some time after unsprayed plants in neighboring fields had begun to die. The fact that the plots sprayed with arsenate of lead were greener than the bordeaux plots would indicate that the former may have acted in some way to stimulate the vines. No definite statement to this effect can be made, however.

TABLE 4

Arrangement of Plots and Yields Per Acre in the Spraying Experiment With the American Giant Variety.

Section 1					Section 2					Section 3				
Treatment	All Plots	Calculated	Check	Difference	Treatment	All Plots	Calculated	Check	Difference	Treatment	All Plots	Calculated	Check	Difference
	bu.	bu.	bu.	per cent		bu.	bu.	bu.	per cent		bu.	bu.	bu.	per cent
Check	245.0				Check	273.1				Check	286.0			
Bordeaux	188.3	230	123	—41.7	Bordeaux	229.1	264.0	115	—34.9	Bordeaux	265.1	285.0	107	—19.1
Calcium arsenate	188.3	215	114	—26.7	Calcium arsenate	207.3	255.1	123	—47.8	Calcium arsenate	207.3	284.1	137	—76.8
Check	200.0				Check	246.2				Check	283.2			
Bordeaux	193.6	208.8	107	—15.2	Bordeaux	253.3	260.1	102	—6.8	Bordeaux	271.3	292.1	107	—20.8
Paris green	196.6	216.8	110	—20.2	Paris green	245.4	274.0	111	—28.6	Paris green	263.5	301.0	114	—37.5
Check	226.5				Check	287.8				Check	309.0			
Bordeaux	188.3	226.5	120	—38.2	Bordeaux	220.0	284.5	129	—64.5	Bordeaux	237.9	303.6	127	—65.7
Calcium arsenate	233.3	226.5	97	6.8	Calcium arsenate	266.6	281.2	105	—14.6	Calcium arsenate	260.5	297.3	114	—36.8
Check	226.5				Check	277.9				Check	291.0			

At harvesting time, most of the plots in the experiment were dug before the yields could be taken. As a result of this the yields on only ten plots were obtained. Each of these plots was divided into three sections in harvesting. In this way, three or more duplications of each treatment were secured. The arrangement of the plots together with the yields per acre are given in table 4.

It will be seen from the table that the yields of the bordeaux plots are lower than those of the arsenate of lead plots. The difference between the yields of the bordeaux, calcium-arsenate and paris-green plots is so small as to be well within experimental error. The average yields of the plots receiving the various treatments are summarized below:

Arsenate of lead	262.8 bushels per acre
Paris green	235.1 bushels per acre
Bordeaux mixture	228.3 bushels per acre
Calcium arsenate	227.2 bushels per acre

In connection with the tests of the different spray mixtures the experiment was designed to determine the most efficient pressure of applying the sprays. As has been previously indicated, there were four duplications of each spray treatment; two of these were applied at 150 pounds' and two at 250 pounds' pressure. Since the yields were not obtained from all the plots the results were incomplete, but those secured are given in table 5.

TABLE 5

Effect of Applying Sprays at Different Pressures

Treatment	Pressure	
	150 lbs.	250 lbs.
	bu. per acre	bu. per acre
Bordeaux mixture	215.7	227.5
Arsenate of lead	258.9	266.5
Calcium arsenate	253.4	200.9
Paris green	235.1	.....

The plots sprayed with bordeaux mixture at 250 pounds' pressure gave an increase of 11.8 bushels over those sprayed with 150 pounds. The results obtained with the insecticides are contradictory and no conclusions can be drawn from the data at hand.

An effort was made to determine if any benefit would follow an early application of bordeaux mixture. Four plots were sprayed with bordeaux when the plants were 6 inches high, and four others were sprayed when the plants were from 2 to 4 inches high. This early application was made in an effort to control flea beetles. When the plants are of this size, it is difficult to reach the lower leaf surface; this may account for the fact that very little control resulted. The average yield of the plots that received the early application was 17.8 bushels less than the yield of the plots where the early application was not made. No differences were observed between these plots during the summer, so there is no reason to believe that the plants were injured by the early application.

The conflicting results obtained from spraying the American Giant variety this year are in accord with those obtained in the experiments previously conducted with this variety. It is possible that varietal differences may be an important factor in potato spraying experiments. This would appear probable in view of the fact that most of the experiments with Cobblers conducted in past years have given positive results. The American Giant variety makes a rapid growth, soon filling the rows, making it impossible to continue the spray applications late in the growing season. While the results obtained this summer would not indicate this to be the reason for the lack of success in spraying this variety, it might help to account for it.

Late-Crop Spraying Test in Cooperation with J. Harry Kandle, Elmer, N. J.

The soil on which this test was conducted is a Sassafras loam in good condition. The field was without irregularities. The variety Irish Cobbler was planted. One ton of a 4-8-3 fertilizer was applied per acre at the time of planting, August 6. The field was divided into 19 plots, each 4 rows wide. The arrangement of the plots was such that a check plot alternated with each sprayed plot. There were no insects of any kind present so that it was possible to leave the check plots unsprayed. The treated plots were sprayed with bordeaux mixture, the 5-5-50 formula being used.

Four spray applications were made. The first one, on September 12, was made when the plants were about 9 inches high; the delay in making the first application had no influence on the results, since there were no diseases present in the field at that time. At the time of the second application, September 19, there was a slight amount of early blight on the unsprayed plants. The third application was

made September 29. At this time, three plants infested with late blight were found in the check plots. At the time of the fourth application, October 9, 75 per cent of the leaves on the unsprayed plants were infested with late blight while there was only a trace on the sprayed plots.

A thorough examination of the field was made October 21, and at that time 3 per cent of the leaves on the sprayed plots were dead. The appearance of the check plots at this time was interesting. As has been stated, the plots were all 4 rows wide; in every case the plants in the two central rows of the check plots were dead. On the

TABLE 6

Arrangement of Plots and Yields per Acre of the Potato Spraying Test with Late-Crop Cobblers

Treatment	All Plots	Calculated Check	Difference
	bu.	bu.	bu.
1. Check	121.9	.....	....
2. Bordeaux	172.2	126.8	45.4
3. Check	131.8	.....	....
4. Bordeaux	190.1	126.2	63.9
5. Check	120.7	.....	....
6. Bordeaux	166.6	127.9	38.7
7. Check	135.1	.....	....
8. Bordeaux	185.0	138.0	47.0
9. Check	140.9	.....	....
10. Bordeaux	172.2	138.9	33.3
11. Check	136.9	.....	...
12. Bordeaux	196.2	138.9	57.3
13. Check	140.9	.....	....
14 Bordeaux	192.3	136.1	56.2
15. Check	134.7	.....	...
16. Bordeaux	195.1	135.8	59.3
17. Check	132.5	.....	....
18. Bordeaux	181.1	132.6	48.5
19. Check	131.9	.....	....

two outer rows, adjoining the sprayed plots, the inner half of the vines was dead while the side toward the sprayed plots was still green and vigorous. This was the result of some of the spray mixture reaching the outer side of the plants. In measuring the yields the outer rows of each plot were discarded.

The treatments of the various plots together with the yields per acre are given in table 6. The average yield of the check plots was 132.6 bushels per acre and of the sprayed plots 183.4 bushels, a difference of 50.8 bushels in favor of the spray treatment.

Spraying experiments with the late-planted crop have given increases every year, even in the absence of late blight. This crop is planted late so that the vines will still be green when killed by frost, thus insuring seed of high vitality. This year a large part of the crop in South Jersey was dead for several weeks before frost, as a result of the epidemic of late blight. In this crop the yield is secondary in importance, the vitality of the tuber for seed purposes being the primary consideration. In view of this fact, the benefits to be derived from spraying the late crop cannot be measured by an increase in yield alone. While it is doubtless true that the differences obtained would not be as marked every year as they were this year, it is probable that spraying would hold the vines for some time. This consideration alone would possibly warrant the adopting of the practice of spraying the late crop.

SEED TREATMENT FOR THE CONTROL OF POTATO SCAB

WM. H. MARTIN

Seed treatment for the control of potato scab has been recommended for a number of years but the practice has not been generaly adopted in the important potato producing areas of the state. In some instances the omission of seed treatment is due to the fact that failure resulted from previous attempts. Where this occurred, it was largely due to the fact that the treated seed was planted in scab-infested soil. Under these conditions seed treatment will no doubt be of some value but will not insure a clean crop. In a small number of cases, injury has followed seed treatment; very frequently this has been due to the improper treatments, such as treating after the sprouts are well developed, employing too strong a mixture or allowing the tubers to remain too long in the solution and treating after cutting.

The principal reason for the failure to adopt seed treatment lies in the fact that the practice consumes so much time. The present recommendation for seed treatment is to soak the tubers for 1½ hours, which makes it practically impossible to treat the seed fast enough to keep ahead of the planter. This is especially true where a large acreage is planted; to treat enough seed for fifty or more acres would require the entire time of two men for several weeks at a time when they would be needed for other work.

Since the length of the time period has deterred the growers from treating seed, experiments were conducted to determine if this could be reduced without loss of efficiency. In connection with this, tests were conducted with both formaldehyde and mercuric chloride (corrosive sublimate) to determine which would give the best control of scab. The formaldehyde solution used was made up at the rate of

1 pint of 40 per cent formalin to 30 gallons of water; the mercuric chloride at the rate of 4 ounces to 30 gallons of water. In every case the solutions were used for only one lot of potatoes, when they were renewed. This was done to insure that all the solutions be of the same strength for the different treatments. In all there were four treatments as follows: 1 hour, ½ hour, ¼ hour and sprinkled. For the first three treatments, the different lots of potatoes were placed in wooden containers and covered with the solution to be tested. They were so left for the desired time period, and then were removed and dried. The potatoes that were sprinkled were placed in a heap and covered with a burlap bag for 30 minutes.

The seed used was a vigorous strain of home-grown Irish Cobblers. To insure the presence of the scab organism, scabby seed was planted, tubers being selected that showed approximately the same amount of scab. In cutting the seed, care was taken to have the seed pieces the same size, in order to eliminate differences that might arise from the use of seed pieces of different weight.

TABLE 1

Effect of Seed Treatment on Germination

Formaldehyde Treatment	Stand	Mercuric chloride Treatment	Stand
	per cent		per cent
1 hr.	98.4	1 hr.	98.0
½ hr.	98.8	½ hr.	96.8
¼ hr.	98.4	¼ hr.	98.8
Sprinkled	96.3	Sprinkled	97.2
Check	91.5	Check	91.5

The soil on which the experiment was conducted is a Penn loam in good condition. Sixteen hundred pounds of a 4-8-3 fertilizer per acre was applied at the time of planting, April 22. The field was divided into 24 plots, each 69 feet long and two rows wide, approximately one-fiftieth acre. These plots were laid out so that a check plot was left between each two treated plots, making eight in all. Each of the treatments was repeated twice.

On June 2 a count was made of the number of plants up. The results of this count are recorded in table 1, which gives the averages for the different plots.

It will be seen from the table that the germination of the treated plots was practically the same. The average for the formaldehyde treatments was 97.9 per cent, and 97.7 per cent for those treated with mercuric chloride. The average for the check plots was 91.5 per cent. At the time of this observation, the plants on the treated plots were for the most part uniform in size while on the check plots some were up 6 inches and others had just appeared above the ground. The vines on the treated plots were larger throughout the early part of the summer than those on the untreated. As the season advanced this difference was not so marked.

TABLE 2

Effect on Yield and Scab Control of Treating Seed Tubers With Disinfectants

Treatment	Total Yield per Acre	Primes per Acre		Seconds per Acre		Unsalable Scabby per Acre		Scabby in Primes
	bu.	bu.	per cent	bu.	per cent	bu.	per cent	per cent
Formaldehyde 1 hour	147.4	134.7	91.3	8.2	5.6	4.5	3.0	18.4
Formaldehyde ½ hour	175.3	159.0	90.7	8.6	4.9	7.7	4.3	17.9
Formaldehyde ¼ hour	158.9	144.9	91.1	6.3	3.9	7.7	4.9	30.2
Formaldehyde sprinkled	146.4	130.9	89.4	8.2	5.7	7.3	4.8	29.9
Mercuric chloride.. 1 hour	178.6	159.0	89.2	11.9	6.5	7.7	4.2	17.2
Mercuric chloride.. ½ hour	148.3	131.5	88.6	8.2	5.6	8.6	5.7	26.6
Mercuric chloride.. ¼ hour	184.5	166.8	90.0	9.1	5.0	8.6	5.0	21.3
Mercuric chloride.. sprinkled	174.7	149.8	85.7	12.7	7.2	12.2	7.0	31.4
Check	145.6	117.8	80.9	10.3	7.2	17.5	11.8	43.9

Table 2 presents the yields of the different plots calculated as averages for the treatments. After the total yield for each plot was determined the tubers were sorted into three classes, namely, primes, seconds and unsalable scabby. The latter class was composed of tubers covered with the scab lesions. Tubers showing only a few lesions were included in the primes. A count was then made to determine the per cent of scabby tubers in the primes. It will be

seen from the table that the benefits derived from seed treatment are not to be measured by the control of scab alone, since an increase in total yield resulted from all the treatments. The average for the formaldehyde treatments shows a gain of 24.6 bushels per acre over the check plots. The average increase for the mercuric chloride treatments was 33.9 bushels per acre.

Summary

1. Untreated scabby tubers gave a low yield, 11.8 per cent of which were unsalable on account of scab. The salable tubers were of low grade, 43.9 per cent being scabby.

2. Scabby seed treated with either mercuric chloride (1 to 240) or formaldehyde (1 to 1000) gave a better stand than untreated scabby seed.

3. Soaking scabby seed in either of these solutions led to increased yields.

4. The formaldehyde treatment for ½ hour gave a greater increase of salable primes than the 1-hour treatment.

5. The mercuric-chloride treatment for ¼ hour gave a greater increase of salable primes than the 1 or ½-hour treatments.

6. The 1-hour treatment with either solution gave slightly better control of scab than the shorter treatments.

7. Soaking the seed for 15 minutes in either solution gave very good control of scab and a marked increase in salable primes over the check plots.

8. Sprinkling tubers with either formaldehyde or mercuric chloride not only reduced the amount of scab but increased the total yield, indicating that this method has some value.

THE INFLUENCE OF SULFUR ON SOIL ACIDITY AND THE CONTROL OF POTATO SCAB

WM. H. MARTIN

The investigations on the control of potato scab conducted by H. C. Lint (3) in 1914, 1915 and 1916 were resumed this year.

While the results of previous experiments with the use of elemental sulfur for the control of scab have been contradictory, the evidence as a whole indicates the possibility of its use in this connection. In view of the fact that potato scab is becoming more and more destructive, it was thought advisable that further research be conducted on this problem. Since the presence or absence of the scab organism appears to be determined to a large extent by the soil reaction, in the work this year particular attention was given to the relation of

the organism to soil acidity as measured by the hydrogen-ion concentration and the relation of the latter to the amount of sulfur applied to the soil.

Experimental

During the summer of 1919, five field experiments were conducted. These experiments were performed on soil of different types, including sandy loam, Sassafras loam and Penn loam. In selecting the fields in which the experiments were conducted, care was taken to avoid any marked soil irregularities so that differences arising from soil variations might be reduced to a minimum. As an additional precaution check plots were left between every two treated plots and each treatment was repeated at least three times. The size of the plots in the different experiments varied from 1/40 to 1/60 acre. Except for the sulfur treatments all the plots of an experiment were treated alike as regards fertilization and cultivation.

Sulfur was used in amounts varying from 300 to 1,200 pounds per acre. The sulfur used was the commercial flour sulfur. The applications were made broadcast after the land was harrowed and just before planting. In one of the experiments the sulfur was applied by hand, in two others a lime distributor was employed while in the remaining two the applications were made with a grain drill. The latter method proved the most efficient, since the sulfur was thoroughly mixed with the surface soil and a more uniform distribution was secured.

Experiments were conducted with the varieties American Giant and Irish Cobbler. When the potatoes were harvested they were separated into two classes, primes and seconds, the latter including all tubers under 1½ inches. The primes were then divided into classes depending on the degree of infection. In grading the primes of the American Giant variety, two classes were made, clean and scabby, the latter including all tubers showing any scab lesions. Three classes were made of the Irish Cobbler primes, namely, clean, salable scabby and unsalable scabby. The last class was made up of all tubers covered with the scab lesions, while tubers showing only a moderate infection were designated salable scabby. In this connection it must be stated that the percentage of salable scabby tubers in the primes is not a fair index of the actual control of scab since the salable scabby tubers from the check plots showed considerably more scab than those from the treated plots. This is particularly true of the American Giant variety; the primes in the sulfur-treated plots not only showed less scab than those from the check plots but were of a much better color and texture.

Before making the sulfur applications soil samples were taken in the area to be included in the experiment and the hydrogen-ion concentration of water extracts of the soil samples determined colormetri-

cally following the work by Clark and Lubs (1) in the preparation of the buffer mixtures, the selection of suitable indicators and with general methods of procedure. When the crop was harvested, soil samples were taken in each plot and similar determinations were made. In taking the soil samples borings were made to a depth of 6½ inches. at intervals of 15 feet. These individual samples were then thoroughly mixed and a sample taken to represent the condition of the plot in question.

In preparing the water extracts of the soil samples to be tested a method was adopted which was essentially the same as that employed by Gillespie and Hurst (2). To 15 gm. of air-dry soil which had been passed through a 1-mm. sieve, was added 30 cc. of distilled water in a 100-cc. Erlenmyer flask. The flask was then shaken 75 times, when it was allowed to stand for a time period of 8 to 12 hours. The supernatant liquid was then drawn off and distributed to test tubes.

The yields per acre as well as the percentage of scabby tubers is presented in the following tables, in which the data given are averages obtained from at least three replications of each treatment and of six check plots. The yields of second-size tubers are included in the tables; in view of the fact, however, that the sulfur treatments appeared to have no influence on the number of seconds they will not be discussed.

Experiments with Cobblers

Experiment I

The soil on which this experiment was conducted is a sandy loam. In 1912, an application of lime was made at the rate of 1,200 pounds per acre; since that time succeeding potato crops have been severely scabbed. Soil samples taken before the sulfur applications were made showed a hydrogen-ion exponent of 6.15. Sulfur was applied at the rate of 400 and 600 pounds per acre. The effect of the sulfur in total yield and scab control is shown in table 1.

It will be seen from the table that with both the 400 and 600-pound applications there was a marked gain in the number of salable primes with a corresponding decrease in the number of tubers rendered unsalable by scab. In addition to this the per cent of scabby tubers in the salable primes was greatly reduced. It will also be observed that with the increased application of sulfur there was a decrease in exponent values of the soil extracts.

TABLE 1

Influence of Sulfur Applications on Total Yield, Per Cent of Scabby Tubers and Hydrogen-ion Concentration

Treatment per Acre	Total Yield per Acre	Yield of Primes			Yield of Seconds per Acre	pH Values of Soil Extracts
		Salable Clean per Acre	Scabby	Unsalable Scabby per Acre		
	bu.	bu.	per cent	bu.	bu.	
Check*	350.1	163.5	64.6	146.8	39.7	6.03
400 lbs. of Sulfur†	339.1	265.8	29.4	30.2	42.6	5.20
600 lbs. of Sulfur†	342.7	283.2	19.4	25.9	33.4	5.07

* Average of 6 plots.
† Average of 4 plots.

TABLE 2

Influence of Sulfur on Total Yield, Per Cent of Scabby Tubers and Hydrogen-ion Concentration

Treatment per Acre	Total Yield per Acre	Yield of Primes			Yield of Seconds per Acre	pH Values of Soil Extracts
		Salable Clean per Acre	Salable Scabby	Unsalable Scabby		
	bu.	bu.	per cent	bu.	bu.	
Check*	174.0	70.4	57.6	85.9	17.7	5.57
300 lbs. of Sulfur† ...	181.4	144.6	22.4	24.1	12.7	4.77
600 lbs. of Sulfur†	171.9	132.0	23.8	22.9	17.1	4.82

* Average of 6 plots.
† Average of 4 plots.

Experiment II

The soil on which this experiment was conducted is a heavier loam than that on which the first experiment was performed. Sulfur was applied at the rate of 300 and 600 pounds per acre. The results of the sulfur treatment are given in table 2. As in the preceding experiment there was a marked reduction in the yield of unsalable scabby tubers on the treated plots, leading to an increase in the number of salable primes. The plots receiving 300 pounds of sulfur showed an increase in total yield, while the plots treated with 400 pounds of sulfur per acre showed a slight decrease. The differences in either case are small, however, and it is doubtful whether any importance can be attached to them. The initial hydrogen-ion exponent of this soil was 5.6 as compared with 5.57 for the check plots at the time of harvesting. A marked decrease in exponents resulted in the plots receiving the sulfur applications.

TABLE 3

Influence of Sulfur Applications on Total Yield, Per Cent of Scabby Tubers and Hydrogen-ion Concentration

Treatment per Acre	Total Yield per Acre	Yield of Primes		Yield of Seconds per Acre	pH Values of Soil Extracts
		Clean per Acre	Scabby		
	bu.	bu.	per cent	bu.	
Check*	144.3	128.4	60.0	14.7	6.27
300 lbs. of Sulfur†	147.0	135.4	43.6	11.6	5.90
600 lbs. of Sulfur†	134.4	119.4	26.9	15.0	5.83
900 lbs. of Sulfur†	156.2	141.8	26.3	14.1	5.13
1200 lbs. of Sulfur†	156.6	142.5	15.7	14.1	5.10

* Average of 8 plots.
† Average of 3 plots.

Experiment III

The soil on which this experiment was conducted is a Penn loam that had not been planted in potatoes for a number of years. To insure the presence of the scab organism in the soil, scabby seed was planted. Sulfur applications were made at the rate of 300, 600, 900 and 1,200 pounds per acre. The results of this experiment are given in table 3.

On the basis of total yield the plots treated with sulfur at the rate of 600 pounds per acre showed a decrease of 9.9 bushels per acre as compared with the check plots. Each of the other plots showed an increase in yield. This increase was 2.7 bushels, 11.9 bushels and 12.3 bushels per acre for the plots treated with 300, 900 and 1,200 pounds of sulfur, respectively. In this experiment no tubers were rendered unsalable by scab. From table 3 it will be observed that the per cent of scabby tubers in the primes decreased with the increased sulfur applications, the plots receiving the highest sulfur application yielding the lowest per cent of scabby tubers. With the increased application of sulfur there was a corresponding decrease in hydrogen-ion exponent values, the plots receiving the 1,200-pound treatment showing the lowest values and the lowest per cent (15.7) of scabby tubers among the primes.

Experiments with the American Giant Variety

Experiment I

The soil on which this experiment was conducted is a heavy loam that had produced severely scabbed potatoes the preceding year. Sulfur was applied at the rate of 300 and 400 pounds per acre. The results of the experiment are given in table 4. On the basis of total yield, the treated plots showed an increase over the untreated check plots, this increase amounting to 20.5 bushels per acre for the 300-pound treatments and 5.8 bushels per acre for the 600-pound treatments. From table 4 it will be seen that the per cent of scabby tubers in the primes was greatly reduced by the sulfur treatments. Of the total yield of prime tubers from untreated plots, 82 per cent were diseased while the plots treated with 300 pounds of sulfur per acre and those receiving the 400-pound treatment gave total yields of primes of which only 23.6 per cent and 15.8 per cent, respectively, were scabby.

The initial hydrogen-ion exponent value of soil extracts was 5.6 at the time of harvesting, average hydrogen-ion exponent value of soil samples from the check plots at time of digging was 5.55. It will thus be observed from table 4 that with each decrease in the value of the hydrogen-ion exponents below that of the check plots, a

corresponding decrease occurred in the per cent of scabby tubers among the primes.

TABLE 4

Influence of Sulfur Applications on Total Yield, Per Cent of Scabby Tubers and Hydrogen-ion Concentration

Treatment per Acre	Total Yield per Acre	Yield of Primes		Seconds per Acre	pH Values of Soil Extracts
		Clean per Acre	Scabby		
	bu.	bu.	per cent	bu.	
Check*	280.8	240.8	82.0	40.0	5.55
300 lbs. of Sulfur†	301.3	247.7	23.6	53.6	5.07
400 lbs. of Sulfur†	286.6	247.7	15.8	38.9	4.90

* Average of 6 plots.
† Average of 4 plots.

Experiment II

This experiment was conducted on a light sandy loam soil underlaid at a shallow depth by a greensand marl. In 1918 potatoes grown in the field had been severely scabbed. Sulfur was applied at the rate of 500 and 700 pounds per acre. The results are presented in table 5. The data of this table indicate a reduction of 44.8 bushels per acre for the plots treated with 500 pounds of sulfur in comparison with the corresponding yields from the check plots. It is questionable, however, whether this decrease in yield can be ascribed to the sulfur treatment, since the plots receiving the 700-pound application gave an increase of 3.5 bushels per acre over the yields from the check plots. A much lower percentage of scabby tubers was obtained from the treated than from the untreated plots. This decrease in the percentage of scabby tubers was much more pronounced than is apparent from the figures given in the table since the tubers from the treated plots classified as scabby showed fewer lesions than did those from the check plots.

In this experiment the amount of scab on the tubers from the treated plots was reduced to only a few lesions. It is doubtful whether scab could be entirely eliminated from the crop even by heavier applications of sulfur, since the exponent values resulting

from the 400 and 700-pound applications are considerably lower than the exponent shown in Gillespie (2) to inhibit the growth of the scab organism in culture media.

TABLE 5

Influence of Sulfur Applications on Total Yield, Per Cent of Scabby Tubers and Hydrogen-ion Concentration

Treatment per Acre	Total Yield per Acre	Yield of Primes		Yield of Seconds per Acre	pH Values of Soil Extracts
		Clean per Acre	Scabby		
	bu.	bu.	per cent	bu.	
Check*	247.3	184.4	64.4	62.8	5.6
500 lbs. of Sulfur†	202.5	161.2	28.8	41.3	4.8
700 lbs. of Sulfur†	250.8	191.6	23.8	59.1	4.8

* Average of 6 plots.
† Average of 4 plots.

Summary

With due regard for the limitations of the experiments here reported, resulting from the fact that they were conducted for one year only, the following points may be advanced.

1. With the different amounts of sulfur used, all gave substantial gains in the number of clean tubers. With the heaviest application, however, scab was not entirely eliminated.

2. The results would indicate that with those varieties of potatoes known to scab severely, the use of sulfur in the proper amount will render a large portion of the crop salable.

3. In all cases, following applications of sulfur, there was an increase in soil acidity as measured by the hydrogen-ion concentration of soil extracts. In most instances this increase in acidity, corresponding to a decrease in hydrogen-ion exponent, was in proportion to the amount of sulfur applied.

4. With a decrease in hydrogen-ion exponent there was a decrease in the number of scabby tubers.

5. The necessity of knowing the soil reaction before sulfur applications are made, is evident from the fact that where the hydrogen-ion concentration of water extracts of soil samples was 5,800 less, the lighter applications (300 to 500 pounds), gave approximately as good

control of scab as the heavier applications (700 to 1,200 pounds). Where the initial exponent was greater than 6.0 the heavier applications gave best control.

6. The results of the present work would indicate that the limiting exponent for the growth of the scab organism is lower in soil than in culture media.

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REPORT OF CORN ROOT AND STALK ROT INVESTIGATIONS, 1919

I. C. HOFFMAN

Indiana Agricultural Experiment Station

in cooperation with

M. T. COOK

The experimental project in New Jersey was organized in cooperation with Dr. M. T. Cook, plant pathologist of the New Jersey Agricultural Experiment Station, and the plot was placed on the College Farm. The object of the experiment was to study the field performance of disease-free and diseased ears as determined by the germination test.

The seed was selected from New Jersey-grown stock at the instance of Dr. Cook and sent to Bloomington, Illinois, where it was germinated and examined by J. R. Holbert. From these ears enough were selected to form an ear-to-row plot of 99 rows. Enough corn was shelled and pocketed from each ear to plant a row. Whatever remnant ears were left were cared for by Mr. Holbert.

For the most part the rows were alternated between disease-free and diseased seed. It was not possible to carry out this plan of arrangement entirely on account of the limited number of ears available. The majority of the ears selected were run in duplicate, while a few others were added to the plot for special studies.

The spot selected for the plot was in the middle of a 7-acre field which was planted to the same kind of corn. At the north and south

ends of the field were patches of standing timber. A hedge of trees and shrubs connected these patches of timber on the west side of the field containing the plot, while four or five large trees stood along the east edge. In this manner the field was protected from high winds which tend to blow the stalks over.

The soil was a retentive loam which was very full of small pebbles and stones. It would probably be classed as a gravelly soil. It differed from the usual gravelly type in that it retained moisture usually well. The land sloped gently to the north and east with the highest part in the southwest quarter. However, the difference in elevation was slight.

The field consisted of an old timothy sod from which a crop of hay was taken in 1917 and 1918, as well as some previous to these seasons. In 1918 it was top-dressed with 300 pounds of acid phosphate and 100 pounds of sodium nitrate per acre. It was probably fertilized with a like amount in 1917, but positive information was not available. In 1919, at the time of plowing and preparing the seed-bed, 8 tons of manure and 450 pounds of acid phosphate and ammonium sulfate in the proportion of 3 to 1 by weight were applied per acre. The soil was plowed deep and harrowed thoroughly. The preparation of the seed-bed was done under the direction of the farm foreman, and labor for planting the plot was furnished by him.

Because of so much rain the planting had to be delayed until May 20 and 21. At this time the entire field was scored in both directions and the boundary of the plot marked by stakes. The rows contained 50 hills each, with 3 kernels of corn per hill. The kernels were placed in the hill by hand and were arranged in the position of an equilateral triangle to afford space for early growth and also to make a uniform type of hill for comparing the growth of the plants. This type of hill also lessened the danger of injury to the plants during cultivation. The kernels were covered with loose soil to a depth of 1 to 1½ inches. The covering also was done by hand to insure uniformity. The surrounding corn was planted with stab planters.

The corn seedlings came up between May 26 and 28, and on June 13 the first notes were taken on stand and vigor of the plants. On the same day, cultivation was begun and the first cultivation was completed on June 14. In all, three cultivations were given the plot during the season. More should have been given but it became impossible because of the lack of farm labor.

At the time of taking the first notes the plants were about the same size. They had become established and their roots were spreading in the soil. Evidence of disease was showing in occasional plants as indicated by lack of color and size. While the difference in size was not great, it was, however, sufficient to detect the strong, medium and weak plants. In several cases, the seed for planting certain rows was taken from ears which showed a large amount of infection with the ear rots. Rows 10, 17, 33 and 37 are examples of this,

and the effect on the original stand is very marked. Row 10 has 63 plants; no. 17 has 16; no. 33 has 89, and no. 37 only 9. In each of these rows the plants were very uneven in size and irregular in color.

A close examination of the ears from which the seed for each row was taken showed a marked difference in composition. The range ran from medium starchy, through various grades to very horny. Two classes, starchy and horny, were established based upon this factor, and the studies following will partially be based upon this condition in comparison with the disease character.

At the time the first examination of the plots was made the total stand was counted and a record taken of the strong, medium and weak plants in each row. Table 1 shows the correlation of initial stand to disease-free and diseased ears.

TABLE 1

Initial Stand June, 1919

Group	No. of Rows	Total Stand	Strong	Medium	Weak
		per cent	per cent	per cent	per cent
Disease-free	78	94.6	94.3	3.5	2.2
Ears with scutellum discolored	8	80.6	90.9	4.9	2.4
Diseased	11	79.3	84.0	9.2	5.8

The data here presented show that the disease-free ears gave a larger total per cent of initial stand and also a greater per cent of strong plants than those of the other groups. Consequently there were less medium and weak plants produced. The group with ears containing discolored scutellums, which were suspected of being diseased, produced an average stand of 80.6 per cent with a larger percentage of strong and fewer medium and weak plants than the diseased ears, but the stand and the vigor were somewhat less than those in the disease-free group.

Table 2 is a correlation between initial stand and composition in disease-free and diseased ears. The starchy corn produced a larger stand with a larger per cent of strong plants than the horny type in the disease-free group. In the groups of ears showing seedlings with discolored scutellums and disease, the larger stands were produced in the horny type while the largest percentages of strong plants came in the starchy type of seed.

In August the final counts for stand were made, as shown in table 3. The corn plants were practically full-sized and the ears had just been pollinated. As in the first count the disease-free corn maintained a decided increase in total stand over the other groups. The per cent of strong plants was decidedly greater and the percentages of medium and weak plants were significantly smaller than those in the diseased ears, respectively.

TABLE 2

Composition in Relation to Initial Stand, June, 1919

Composition	Disease-free Ears				Ears with seedlings showing discolored Scutellums				Diseased Ears			
	No. of Rows	Initial Stand	Strong Plants	Per cent Strong	No. of Rows	Initial Stand	Strong Plants	Per cent Strong	No. of Rows	Initial Stand	Strong Plants	Per cent Strong
Starchy	45	143	136	95.1	4	112	104	92.8	4	114	99	86.8
Horny	33	141	133	94.3	4	128	117	91.4	7	121	99	81.8

TABLE 3

Final Stand, August, 1919

Group	No. of Rows	Total Stand	Strong	Medium	Weak
		per cent	per cent	per cent	per cent
Disease-free	78	92.6	91.3	4.2	5.0
Ears with scutellum discolored	8	77.3	93.0	0.8	6.0
Diseased	11	76.0	77.1	11.4	12.2

Ears showing seedlings with discolored scutellums had a much smaller stand than the disease-free ears, and slightly greater than those from diseased ears.

The differences between the stands of the disease-free and diseased rows at the beginning and the close of the season remained relatively the same, indicating that when the plants of disease-free or diseased seed are once established in the soil, both classes are subjected largely to the same influences that effect mortality.

In comparing the effect of the composition on the stand in rows planted with disease-free and diseased seed at the end of the season, it is observed in table 4 that the same facts hold that were found at the beginning of the season. The starchy corn produced a greater stand than the horny ears. The total number of plants from the horny diseased type is considerably reduced in comparison with the same type from the disease-free seed, and the number of strong plants is large in proportion to the total stand.

TABLE 4

Composition in Relation to Final Stand, August, 1919

Composition	Disease-free Ears				Ears with seedlings showing discolored Scutellums				Diseased Ears			
	No. of Rows	Final Stand	Strong Plants	Per cent Strong	No. of Rows	Final Stand	Strong Plants	Per cent Strong	No. of Rows	Final Stand	Strong Plants	Per cent Strong
Starchy	45	140	132	94.3	4	107	100	93.4	4	112	97	86.2
Horny	33	138	119	86.2	4	125	122	97.6	7	116	83	71.5

The group of ears with seedlings showing discolored scutellums varied somewhat during the season. The horny type of kernels maintained a larger stand and also attained a higher per cent of strong plants, whereas the starchy type had a larger per cent of strong plants at the time the initial count was made. The horny type in this case had a smaller stand than either group in the disease-free ears, and larger than the same groups from the diseased ears. The starchy corn in this same group produced the lowest stand of any group, but ranked third in per cent of strong plants. All of this indicates that for conditions obtaining at New Brunswick, the disease-free ears of the medium starchy type will produce the greatest total stand and the largest number of strong plants.

Progress of the diseases on the young corn plants was observed by the characteristic chlorosis and wilting effects. In the worst cases

they resulted in blighting and death to the plants. In others, the plants were sufficiently resistant to the disease so that they grew slowly and produced what were classed also as medium and weak plants. Plants that started out as medium and weak ones usually remained as such, except as a medium plant would become weak, or a weak one die through the progress of the disease.

Later, when the stalks were about full grown, an index to the root development was given through the numbers of broken and down stalks. Just before harvest time, this condition was at its worst. The leaning, broken and down stalks were not confined to definite rows but were generally found in the entire plot. The stalks did not lie in a single direction as if a high wind had blown them over, but they seemed to fall in all directions, leaving the plot in bad condition for harvesting. From what is known of the effect of root development on the ability of corn to stand up, it appears that the root systems of the plants in this soil were badly infested. However, no examinations were made so no conclusions can be drawn.

TABLE 5

Composition in Relation to Yield, 1919

Composition	Disease-Free Ears		Ears with Seedlings Showing Discolored Scutellums		Diseased Ears	
	No. of Rows	Yield	No. of Rows	Yield	No. of Rows	Yield
		bu.		bu.		bu.
Starchy	45	76.05	4	73.48	4	55.73
Horny	33	67.07	4	71.00	7	50.98

The corn surrounding the plot was cut and shocked when it was sufficiently matured. The plot was left uncut and allowed to ripen as normally as possible. Labor for husking and storing the crop was furnished by Dr. Cook and the farm manager. As soon as the corn had dried sufficiently the ears were husked from the uncut stalks and carried in baskets to the east end of the rows and piled separately. The yield of each row was then weighed accurately on platform scales and the weights recorded, after which the corn was turned over to the farm manager.

The yields of the various groups with respect to disease and composition are given in table 5.

Three sets of comparisons are presented with respect to composition and disease characters.

The yield of starchy corn is 8.98 bushels per acre larger than that of the horny corn in the disease-free group. It was 2.48 bushels greater in the group of ears showing seedlings with discolored scutellums, and 4.75 bushels greater in the diseased group of horny seed. The starchy disease-free group yielded more than any other group and the horny diseased group yielded the least.

TABLE 6

Yield Data, October, 1919

Row No.	Yield Per Acre	Row No.	Yield Per Acre	Row No.	Yield Per Acre
	bu.		bu.		bu.
1	67.13	34	70.21	67	89.92
2	81.29	35 SD	77.15	68	82.45
3	60.51	36	84.68	69	78.22
4	52.19	37 D (out)	5.23	70	66.50
5	51.27	38	92.53	71	66.67
6	63.74	39 SD	66.05	72	83.30
7	64.20	40	80.99	73	74.98
8 D	50.81	41 D	64.67	74	82.37
9	60.51	42	74.06	75	86.53
10 D	25.25	43 D	59.12	76	70.82
11	51.73	44	67.13	77	62.36
12 D	49.88	45	52.88	78	67.44
13	54.50	46 SD	79.14	79	67.90
14	58.20	47	72.21	80	73.13
15	50.81	48	79.89	81	85.53
16	53.58	49	82.79	82 SD	68.95
17 D (out)	3.38	50	77.29	83	81.91
18	62.86	51	66.20	84	74.06
19 D	43.26	52	81.91	85	103.31
20	63.74	53	57.13	86 SD	66.97
21	90.38	54	75.29	87	65.59
22	50.81	55	86.53	88	80.52
23 D	53.58	56 SD	73.13	89	60.05
24	45.26	57	72.60	90	80.52
25	59.12	58	74.98	91	68.98
26	65.13	59	85.14	92	91.15
27 SD	71.59	60 SD	74.98	93	62.05
28	70.82	61	68.98	94	87.30
29 D	60.42	62	74.98	95	79.14
30	66.50	63	69.44	96	72.60
31 D	71.59	64	87.45	97	94.07
32	63.74	65	66.67	98	82.37
33 D	48.96	66	70.36	99	74.98

SD—Scutellum discolored.
D—Diseased.
Unmarked row numbers—Disease-free ears.

FUNGI INJURIOUS TO PAINTS

C. M. HAENSELER

Studies on fungi injurious to paints were begun in July, 1916, and carried on until September, 1917, at which time the writer entered military service. The studies were resumed again in September, 1919, and are still in progress.

The problem was considered in a very general way and an attempt was made to make a survey of the field as a whole, rather than to undertake an exhaustive study of any particular phase. Attempts were made through observations and experimental studies to throw light on the following:

1. The prevalence and economic importance of fungous injury to paints.
2. The species of fungi causing the injury.
3. The nature of the injury.
4. The source of food for these fungi.
5. The environmental conditions necessary for their development.
6. The relative growth of fungi on paints of various composition and on paints applied to various woods.
7. Possible control measures.

Fungi growing on painted and varnished surfaces have been found to be very generally distributed and of much more common occurrence than heretofore has been suspected. They are found abundantly both on exterior and interior painted surfaces, wherever the proper conditions are presented.

It is difficult to get even an estimate as to the economic importance of these paint-inhabiting fungi. Apparently the only direct reference which is printed concerning losses of paint due directly to fungi, is given by Massee (2), who states that in one case a number of newly painted greenhouses had to be repainted on account of a severe reddening of the wet paint due to the presence of a fungus growth. Such a complete ruination of a freshly applied paint is doubtless very rare. The greater injury is caused by the blackening and mottling of white painted surfaces after a considerable length of time. In such cases the surface finally becomes so unsightly that a new aplication of paint must be made on account of the appearance, long before the old coat has lost its real protective power.

The species of fungi found on painted surfaces are quite numerous but the forms which are constantly associated with paint discoloration are relatively few. Such forms as *Alternaria, Aspergillus, Penicilium, Sporotrichum* and variuos yeasts and bacteria are frequently gotten in petri-dish cultures from discolored paint surfaces but these forms are usually not the cause of the discoloration. In certain cases *Aspergillus* and *Penicilium* have been found to be the principal fungi present and the sole cause of the discoloration, but they have not been found to be very prevalent. Bacteria and yeast are found only on very moist surfaces and are unimportant in connection with these studies.

Dematium pullulans DeB. & L., several species of *Cladosporium*, two species of *Phoma* and an unidentified fungus with a red-brown mycelium have been found to be the important species causing discoloration on painted surfaces. *Cladosporium* and *Aspergillus* have been found causing considerable injury to varnished surfaces.

Each species causes a specific type of spotting or discoloration, and as a rule, the species of the fungus can be determined from the characteristics of the colonies and the color produced on the underlying paint.

The discoloration of the paints may be due to the presence of black or brown hyphæ or resting bodies (*Dematium, Cladosporium, Phoma* sp.), or to the presence of masses of highly colored spore masses (*Aspergillus, Penicilium*), or to the production by the fungus of soluble pigments which discolor the paint itself (*Phoma pigmentivora*). Discoloration varies, with the species, from a very uniform darkening of the entire surface (*Dematium*) to small black specks (*Cladosporium*) or to large irregular red, or reddish brown blotches (*Phoma* sp.).

Careful observations and experiments have been made to determine the source of food of the paint-inhabiting fungi. A series of experiments were made to test the ability of the various fungi to use linseed oil as a food. None of the fungi were able to derive their full nourishment from the oil. In agar containing nutrient salts, however, they were able to break down the oil and utilize it as a source of carbon. Panel tests seem to indicate that the fungi are unable to make an appreciable growth on perfectly clean painted surfaces. A very small amount of nourishment added to the surface allows a considerable growth. Whether or not the fungi are able to attack the oxidized oil film and utilize this as a source of energy has not been determined definitely. Observations and experiments seen to indicate that, as a general rule, the fungi which grow on painted surfaces, especially those which produce colonies, derive their nourishment from foreign matter which happens to be on the paint, but that in certain cases it seems probable that they may utilize the oil of the paint or its disintegration products as a source of energy.

The environmental conditions to a very large extent control the presence of fungi on paints. In greenhouses with relatively high temperature and humidity these fungi are most prevalent. Even in the greenhouse certain species are very localized on account of the favorable environments at certain points. Other species, such as *Dematium pullulans*, are very indifferent and may grow luxuriantly either on moist or dry interior surfaces or on exposed exterior surfaces.

A large number of panel tests have been conducted to determine the relative growth of fungi on the various types of paint. White lead (carbonate), white lead (sulfate), zinc oxide, lithopone, a mixed paint (50 per cent lead, 50 per cent zinc) and a ready-mixed commercial paint were included in the tests. Some of these panels were exposed to the atmosphere and natural infection in greenhouses;

other small panels were inoculated with pure cultures and exposed in aerated moist chambers. Some of the tests were made by applying the paints directly to the interior wood and steel work of a greenhouse. The panels have been exposed for from 6 months to 3 years, the majority of the panels still being under observation. The greenhouse and laboratory panels, as well as general observations, show that lithopone is readily subject to fungus attack. Even after 6 months' exposure lithopone showed very severe blackening due to fungi. Next to lithopone, pure white lead (carbonate) is the most subject to attack. The pure lead panels in all cases showed severe blackening and spotting due to fungi, while zinc oxide and mixed paints showed only occasional colonies.

Culture tests were made to test the relative toxicity of lead carbonate, lead sulfate and zinc oxide pigments. Lead carbonate proved to be the least toxic. Zinc oxide was the most toxic to some of the fungi, lead sulfate to others. The fungi were able to grow in the presence of large amounts of all of these pigments.

Tests to determine whether the purity of the linseed oil used in mixing paints affected the fungus growth on these paints failed to show any noticeable difference between ordinary linseed oil and a special purified grade.

White pine, spruce and cypress panels, when painted with the same paint, all developed fungi alike. The different woods did not affect the kind or amount of growth.

A series of panel experiments were conducted to determine the possibility of preventing the growth of fungi on paints by means of adding various antiseptics and poisons to the paints before application. One per cent by weight of copper sulfate, 4 per cent of benzol and 2 per cent of mercuric chloride, zinc chloride, carbolic acid and toluene, respectively, were added to the second coat of paint before application. All of these treated paints developed a good growth of fungi. *Dematium* and *Cladosporium* developed on all the paints alike. The *Phoma* sp. and the red-brown unidentified fungus seem to be more sensitive to the antiseptics. These species were found to have somewhat less growth on paints treated with copper sulfate and mercuric chloride. Although Massee (2) and Gardner (1) have recommended antiseptics as a control for fungi on paints these tests seem to indicate that antiseptics and fungicides added directly to the paints are not especially effective.

The studies on fungi injurious to paints are still in progress. The laboratory tests and greenhouse panels will be continued for at least another year before a final report is made.

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CELERY DISEASE INVESTIGATIONS

ROBERT F. POOLE

Experiments conducted by W. S. Krout in 1916 and by the writer in 1917 in the Oradell-Ridgewood region of Bergen County have in part been continued. Some of the chemical disinfectants applied to the diseased areas have been eliminated, because toxicity resulted in some cases without control of the diseases. Other compounds which gave promise of control were applied this season in greater amounts. Data to be collected during the summer may warrant recommending positive or negative results so far as applying chemical compounds to the soil for the control of the soft rot organism is concerned. We are more interested in controlling the disease from a practical standpoint, which interests the farmer. Sterilizing the greenhouse beds with steam or formalin is a valuable asset to every farmer, and when properly applied, damping-off and root-rot diseases are readily controlled in the seed-beds. Hardy green celery varieties have never been as susceptible as the golden self-blanching varieties. In the past few years, however, a great many diseased plants of the green varieties have been seen in the field. The symptoms are the same in all respects as those of the yellow varieties. The bacterial disease has spread to most of the muck-soil farms. Temperature is a great factor because golden self-blanching varieties grow well on diseased muck lands from April to July. After this period, growing golden self-blanching celery results in a complete failure on infected muck soils.

Copper sulfate, ferrous sulfate, hydrochloric acid, potash, phosphoric acid, lime, sulfur, cyanamide and other compounds were applied to the infected land this season in various amounts to determine their effect as disease controls.

Seedling plants were treated in mercuric chloride, 1 to 1,000, for 3 and 5 minutes. Some of the former lived, but even this short exposure was too great for the tender roots and the plants grew very slowly. A copper sulfate solution, 1 pound to 50 gallons of water, gave similar results, but further treatment of this nature was discontinued because of toxicity and stunting of plant growth. Weaker solutions of these disinfectants could not be depended on to control the organism.

Transplanting may prove beneficial; however, plants grown at the Experiment Station in sterilized sandy loam, became diseased in a few cases when grown in infected muck soil. Further trials of transplantings may be worth while.

Very vigorous strains of golden self-blanching celery growing in diseased areas have encouraged breeding for strains resistant to the root rots. Forty mature stalks of celery collected from the diseased

areas were transplanted from the fields into the plant pathology greenhouse at the Experiment Station in November, 1919. Practically all of the plants grew well for a few weeks, some for 4 months. High temperature and high humidity late in November developed and the dormant organism became active to such an extent that 25 of these stalks died in one week by decaying in the heart. Ten more of the plants died in the latter part of March, 1920. Five of the 40 plants selected showed no sign of disease during the winter. Of the seed that formed, some was distributed for quick trial among several of the best celery growers of Bergen County on June 23. This seed will be given a better test next year. If infestation becomes very serious on green celery varieties, strong strains of these varieties will be selected for seed. Celery seeds more than three years old germinate poorly. The vitality of golden self-blanching celery seed is poor in comparison with that of the green celery varieties. From this standpoint alone, we cannot lay too much emphasis on advantages gained by selecting stalks which will produce the very best of seed. Every grower of celery should take pride in growing seed from his own stock, which will give strong plants to begin with.

The organism causing celery root rot has been isolated. Numerous infection experiments have proven its pathogenicity. Green celery varieties and other vegetables have been inoculated with the organism with success. High humidity with a temperature above 80° F, is most favorable for developing soft rots caused by this organism. The number of this organism, following the outline formulated by the Society of American Bacteriologists is 221–1,113,523. Wormwald (2) described an organism with this same number and named it *Bacillus apiovorous*. *Bacillus carotovorous* Jones (1) is perhaps the same organism, or they are two of many strains of a bacillus which produces soft rots of vegetables and other foods. The only contrast between the two organisms as compared by Wormald was a few minor differences of growth in synthetic culture media and the fact that his organism produced yellow chromogens. *Bacillus carotovorus*, on the other hand, was described by Jones as non-chromogenic. The organism isolated is very variable in results unless it is kept revigorated. Carrots became diseased on the diseased muck soil as severely as golden self-blanching celery, and no distinction could be made from the organisms isolated from the celery and carrots. We doubt, therefore, whether even strains of this soft rot bacillus should be given as different species. Experiments have shown that the character of rot symptoms is due entirely to the physiological conditions of both host and parasite.

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HORSE-RADISH ROOT ROT INVESTIGATIONS

ROBERT F. POOLE

In the past few years much horse-radish root rot has been reported from Passaic County. The annual losses, however, do not exceed 2 per cent. The cause of the disease is a bacterium. The disease occurs in a general way, well distributed in the field. Historic facts concerning the disease are more or less conflicting. Some of the older growers claim that they have detected the horse-radish root rot for many years in their fields. Other growers claim that the disease was introduced in the past 4 or 5 years.

The symptoms of the horse-radish root rot are most pronounced about harvest time. The rot is confined to the core of large roots. Rarely if ever is the outer wall attacked. Unless the growers keep the head roots stripped off, there is no way of estimating the amount of diseased roots in a field. The head root system would keep the plant in a growing state even though the main root was decaying. If the head roots are stripped back and the root is infected, wilting and death will result on drying hot days. The rate of transpiration would be too great for the diseased end roots. If one end of a root is badly diseased when it is planted, decay is encouraged by rodents, saprophtic fungi and bacteria. Rodents eat through the outer walls of the roots and soft decay sets in. The interior of a horse-radish root shows a distinct line of demarkation. An outer zone of healthy tissue encloses a core of decaying, water-soaked tissue which is yellowish in color and contains great numbers of bacteria. In older roots a distinct slackening occurs and very old roots become hollow. The horse-radish root is a good medium for the growth of both bacteria and fungi.

Rhizoctonia sp., *Penicillium* sp., *Thielavia basicola* and *Rhizopus* sp., have been constantly isolated from specimens of horse-radish sent to the laboratory and also from many diseased roots found during seed selection. Some of these fungi are known to cause rots of sweet potatoes and other root crops in storage and their relation to the horse-radish rots will be studied in the future.

The general nature of the disease leads us to believe that the disease is present in the horse-radish roots when they are set in the field. Mr. Fisher, a Passaic County farmer, has agreed to cooperate with us in this work. Mr. Wettyen, county agent of Passaic County, also has assisted us in starting the investigation of horse-radish diseases. Experiments are being carried on along the following lines:

1. Selection of disease-free roots for planting.
2. Disinfecting roots with formaldehyde and corrosive sublimate.
3. The effects of acid and alkali soils on the organism.
4. Better methods of storing seed-roots over winter.

The systematic nomenclature of the organism is being studied. It has been isolated and its pathogenicity proven.

PLATE 1

FIG. 1. Brown rot of peach showing infected twigs

FIG. 2. Brown rot of peach showing infected twigs

PLATE 2

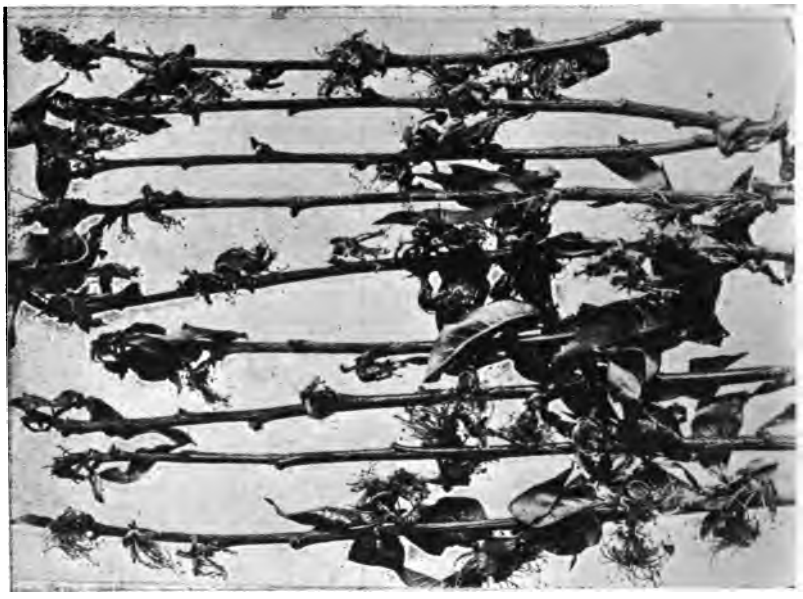

FIG. 1. Brown rot of peach showing infected blossoms and foliage

FIG. 2. Root rot of celery

PLATE 3

FIG. 1. Late blight of celery. Photo taken immediately after the first frost, killing all the leaves that were infected. Killed leaves drooping over edge of boards

FIG. 2. Close view of plants infected with late blight (*Cercospora apii*)

PLATE 4

FIG. 1. Pepper seedlings damping off with *Rhizoctonia*

FIG. 2. Bacterial root rot of horse-radish

PLATE 5

POTATO SPRAYING TEST—Every Other Four Rows Sprayed with Bordeaux Mixture

PLATE 6

FIG. 1—Yield of Prime Tubers from Seed Treated with Formaldehyde for Scab Control Compared with Yield from Untreated Seed
(From N. J. Agr. Exp. Sta. Cir. 122)

FIG. 2—Unsalable Scabby Tubers from Plots Treated with Sulfur for Scab Control Compared with Those from Untreated Plots
(From N. J. Agr. Exp. Sta. Cir. 122)

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REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
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REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

WILLIAM H. MARTIN, PH.D., *Associate Plant Pathologist.*

ROBERT F. POOLE, PH.D., *Assistant Plant Pathologist.*

C. M. HAENSELER, PH.D., *Assistant Plant Pathologist.*

*GORDON W. FANT, B.SC., *Fellow and Assistant in Plant Pathology.*

WILLIAM D. MOORE, B.SC., *Fellow and Assistant in Plant Pathology.*

*Appointed August 1, 1920.

CONTENTS

	PAGE
INTRODUCTION	423
EPIDEMICS	425
OTHER IMPORTANT DISEASES	425
COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE	426
NEEDS OF THE DEPARTMENT	426
THE HERBARIUM	427
DISEASES OF THE YEAR	427
REPORT OF POTATO SPRAYING TESTS	435
INFLUENCE OF SULFUR ON THE CONTROL OF POTATO SCAB	442
INOCULATED VS. UNINOCULATED SULFUR FOR THE CONTROL OF POTATO SCAB	449
THE FERTILIZER VALUE OF SULFUR FOR POTATOES	453
STUDIES OF THE RELATION OF MATURITY TO VIGOR IN SEED POTATOES	456
CELERY DISEASE INVESTIGATIONS	461
REPORT OF SPRAYING TEST AT CAMPBELL'S SOUP FARMS	463
INVESTIGATION OF HORSE RADISH ROOT ROTS	464
INVESTIGATION OF SWEET POTATO DISEASES	466
STUDIES ON EGGPLANT WILT	469
SPRAYING EXPERIMENT FOR THE CONTROL OF PEAR FRUIT AND LEAF SPOT	473
FOLIAGE INJURIES	475

Report of the Department of Plant Pathology

MELVILLE THURSTON COOK

INTRODUCTION

The organization of the department during the past year was very similar to that of the preceding year. Dr. Wm. H. Martin, associate plant pathologist, continues with us as potato specialist and devotes a considerable part of his time to the study of the diseases of potatoes. His special problems in pathology were the control of common scab of the potato by the use of sulfur and spraying for the control of foliage diseases. His report will be found on p. 435-460.

Dr. R. F. Poole, fellow in plant pathology and assistant plant pathologist in charge of work on diseases of sweet potatoes and tomatoes, completed his work on "The Root Rot of the Celery" and received the degree of Doctor of Philosophy on June 14. He has also done considerable work on the root rot of the horse-radish (p. 461-468). He will continue with us as assistant plant pathologist, giving practically all of his time to the study of the diseases of sweet potatoes and tomatoes.

Dr. C. M. Haenseler, New Jersey Zinc Company Fellow, completed his work on "Fungi Injurious to Paints" and received the degree of Doctor of Philosophy on June 14. During the past year he did some work also on the control of the pear fruit and leaf spot (p. 473-474) and the eggplant wilt (p. 469-472). He will continue with us next year as instructor in botany and plant pathology.

William D. Moore (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the root rots of corn and peas.

Gordon W. Fant (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the brown rot of the peach and to seed-bed diseases.

Research

The research work in progress involves the following problems:

In the charge of Mel. T. Cook:
1. The influence of Bordeaux and other spray mixtures on potatoes.
2. The influence of mosaic and leaf roll on the yield of potatoes.
3. The transmission of *Sclerotinia cinerea* from year to year.
4. Studies on the morphology of peach yellows.
5. Causes of tomato rots.
6. Removal of fruit-tree cankers.
7. Diseases of licorice.

In the charge of Wm. H. Martin:
1. Control of foliage diseases of the potato by applications of Bordeaux mixture.
2. Investigation of the use of elemental sulfur for the control of common scab of potatoes.
3. A study of the fertilizer requirements of potatoes.
4. Investigations of tuber-borne diseases.
5. Physiological studies of seed potatoes.

In the charge of R. Frank Poole:
1. Root rot of celery.
2. Root rot of horse-radish.
3. A study of stem rot control of sweet potatoes by seed selection.
4. A study of soil treatments as affecting the control of "soil rot," "pit" or "pox" of sweet potatoes.
5. A study of the dissemination and cause of scurf of sweet potatoes under different soil conditions.
6. A study is being made in general of all storage and field rots of sweet potatoes.

In the charge of C. M. Haenseler:
1. A new wilt disease of the peach.

In the charge of W. D. Moore:
1. Root rot of the pea.
2. Root rot of corn.
3. Control of cherry leaf spot.
4. Control of strawberry leaf spot.

In the charge of G. W. Fant:
1. Brown rot cankers of the peach.
2. Control of seed-bed diseases.
3. Control of the fruit and leaf spot of the pear.
4. Comparative testing of spray and dust for control of apple diseases.

Publications

The Station publications contributed during the year by the department of plant pathology are Bulletin 345, Circulars 122 and 123, and papers of the Journal Series, Nos. 12, 21, 26, 27, and 29.

EPIDEMICS

The rainfall during the spring, summer and fall of 1920 was heavier than usual and weather conditions were very similar to those of 1919. The winter of 1920-21 was exceptionally mild. The early part of March, 1921, was very warm, followed by freezing weather the latter part of March and the early part of April. Several diseases have been severe enough to be listed as epidemics. They are as follows:

1. *The brown rot of the peach* was exceptionally severe in 1919 and 1920, the blossom blight form being very abundant. The early frosts in 1921 killed most of the peach buds. The blossom-blight form of brown rot was severe in some few orchards that escaped the frost.
2. *The late blight of the potato* was very abundant during the latter part of the season of 1920. A more complete discussion will be found on page 435.
3. *The common scab of the potato* was very abundant again in 1920, Dr. Martin reports more fully upon its prevalence, and his studies on its control by the use of sulfur (page 442).
4. The leaf spot of the cherry was very destructive in 1920. It was the subject of one orchard experiment by Dr. C. M. Haenseler and is reported on page 442. It is very severe also in 1921.
5. *The eggplant wilt* continues to be a very important disease. It was the subject of an experiment by Dr. Haenseler and is reported on page 469.
6. *The black leg of the cabbage* is a destructive disease which was very abundant in some places, especially in Camden county. This crop should receive special attention of a well trained plant pathologist.
7. *A disease of tomatoes* which we have designated as *streak* was very destructive. This disease has been observed for several years but was not of much importance until 1920. The Experiment Station literature for a period of nearly thirty years contains references to this or a very similar disease. The disease is more or less prevalent in the greenhouses during the winter and has been the subject of special study by Dr. C. R. Orton of the Pennsylvania Experiment Station. The same or a similar disease is reported from the Pacific Coast. It may be the same as the Grand Rapids wilt. It should receive careful attention of a trained plant pathologist.
8. *A bacterial rot of seed potatoes* after planting was very prevalent in the state, especially in Monmouth county during the early spring of 1921. It was mostly due to *Bacillus vulgarus* but was complicated by the presence of a small amount of *Fusarium* sp. and by wire-worms in many fields. In some cases the losses were quite heavy.

OTHER IMPORTANT DISEASES

Other very important diseases which are worthy of special attention are:

1. *The root rot of the pea* which was so very destructive in 1919 was of little importance in 1920, but an examination of the fields showed that the organism was present. Evidently the weather conditions were unfavorable for its development. It is very destructive in 1921 and will probably result in reduced acreage in the future. Mr. Moore is giving some attention to the problems but it is of sufficient importance to require the full time of a trained man.

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Apple

CROWN GALL AND HAIRY ROOT (*Bacillus tumefaciens* S. & T.). Common on the apple and many other plants. Many apple and peach trees are no doubt weakened by this disease. It is doubtless the cause of poor growths in many cases.

BLACK ROT (*Sphæropsis malorum* Pk.). Very common but no more severe than usual.

BITTER ROT (*Glomerella rufomaculans* (Berk.) S. & van S.). Present but not a serious disease.

BLOSSOM END ROT (*Alternaria* sp.). Very common but not serious. It is very often associated with arsenical injury.

JONATHAN SPOT (*Alternaria* sp.). Very abundant.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Not serious in many orchards.

BLOTCH (*Phyllosticta solitaria* E. & E.). Very severe on the Smith Cider variety.

SOOTY BLOTCH (*Phyllachora pomigena* (Schu.) Sacc.). Not important in well sprayed orchards.

SCAB (*Venturia inequalis* (Cooke) Wint.). Common, especially in unsprayed orchards. More prevalent in 1921 than in 1920.

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very severe in a few localities.

FRUIT SPOT (*Cylindrosporium pomi* Brooks). Quite serious in several orchards which were not well sprayed.

MILDEW (*Sphærotheca mali* (Duby) Burr.). Occasional.

BLISTER CANKER (*Numularia discreta* (Schw.) Tull.). Occasional.

STIPPEN (?). Very common.

WATER CORE (?). Occasional.

LOW TEMPERATURE in early spring, resulting in leaf fall later in the season.

Asters

YELLOWS (cause unknown). This disease is more or less prevalent every year.

WILT (*Fusarium* sp.). Occasional.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). Prevalent throughout the state and destructive.

LEAF AND POD SPOTS (*Diaporthe phaseolus* (C. & E.) Sacc.). Prevalent especially in the southern part of the state, but not very destructive.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Very abundant and very severe throughout the state.

ROOT ROT (*Rhizoctonia*). Very common on the roots and sometimes very destructive.

RUST (*Uromyces appendiculatus* (Pers.) Lev.). Rare.

BACTERIAL BLIGHT (*Pseudomonas phaseoli* E. F. Smith). Occasional early in the season. More prevalent than usual in 1921.

Beets

LEAF SPOT (*Cercospora beticola* Sacc.). Very abundant but not considered of any importance.

Blackberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common but of relatively little importance.

LEAF SPOT (*Septoria rubi* West). Common but of very little importance.

RUST (*Gymnoconia peckiana* (Howe) Tranz.). Common and sometimes destructive.

(See Dewberry and Raspberry)

Cabbage, Cauliflower and Kohlrabi

BLACK LEG (*Phoma lingam* (Tode) Desmaz.). Prevalent in the southern part of the state and very severe in Camden county.

YELLOWS (*Fusarium conglutinans* Wollenw.). Occasional.

BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Occasional, and widely distributed throughout the state.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). Occasional. Sometimes very destructive.

Cantaloupe

(See Muskmelon)

Carnation

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

Catalpa

LEAF SPOT (*Phyllosticta catalpæ* Ell & Mart.). Common and sometimes the cause of heavy leaf fall.

Cedar

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very abundant in restricted localities throughout the state. Reported from Monmouth, Burlington and Cape May counties.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Abundant in the celery-growing districts throughout the state.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Abundant in the celery-growing districts throughout the state.

ROOT ROT (*Sclerotinia libertiana* Fckl.). Occasional, sometimes severe.

CROWN AND HEART ROTS (*Bacterial*). Very severe in some localities (page 461).

Cherry

BROWN ROT (*Sclerotinia cinera* (Bon) Schrot.). Abundant and very destructive.

LEAF SPOT (*Cylindrosporium padi* Karst.). Abundant and destructive.

LOW TEMPERATURE in early spring, resulting in leaf fall later in the season.

Chestnut

BLIGHT (*Diaporthe parasitica* Murrill). Abundant.

Clover, Red

RUST (*Uromyces trifolii* (Hedw.) Lev.). Common but of no importance.

Corn

SMUT (*Ustilago zeæ* (Beckm.) Urg.). Very common and in some cases serious.

WILT (*Fusarium* (?)). Widely distributed throughout the state. It is the subject of special study.

WILT (*Pseudomonas stewarti* E. F. Smith). Occasional in northern part of state. Of no importance.

RUST (*Puccinia sorghii* Schw.). Occasional but of no importance.

LEAF BLOTCH (*Helminthosporium inconspicuum* C. & E.). Common.

Cowpea

LEAF SPOT (*Cercospora dolichii* E. & E.). Common.

Cranberry

SCALD (*Guignardia vaccinii* Shear). Widely distributed and very abundant in the cranberry bogs of the state.

ROT (*Acanthorynchus vaccinii* Shear). More or less common.

ANTHRACNOSE (*Glomerella rufomaculans vaccinii* Shear). *Glœosporium* stage common.

Cucumbers

LEAF SPOT (*Macrosporium cucumerinum* C. & E.). Common and destructive.

DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and destructive.

WILT (*Bacillus tracheiphilus* (E. F. Smith). Very common.

STEM ROT (*Sclerotinia libertiana* Fckl.). Common on plants grown under glass.

Currant

ANTHRACNOSE (*Glœosporium ribis* (Lib.) M. & D.). Very common.

LEAF SPOT (*Septoria ribis* Desm.). Common.

CANE BLIGHT (*Botryosphæria ribis* G. & D.). Common and very destructive.

RUST (*Cronartium ribicola* Kleb.). Reported from two localities.

Dewberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common and sometimes severe.

DOUBLE BLOSSOM (*Fusarium rubi* Wint.). Abundant and sometimes injurious.

RUST (*Gymnoconia interstialis* (Howe) Franz.). Common and sometimes destructive.

LEAF SPOT (*Septoria rubi* West.). Very abundant but of little importance.

Eggplant

LEAF BLIGHT (*Phomopsis vexans* (Sacc. & Gyd.) Harter). Abundant and in some cases destructive.

WILT (*Verticillium albo-atrum* R. & B.). Common and destructive throughout the state (page 469).

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). *Glœosporium* stage common.
LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* (Ell.) V. & R.). Abundant and severe.
DOWNY MILDEW (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.
NECROSIS (*Fusicoccum viticolum* Reddick). Rare.
CHLOROSIS. Caused the loss of several plants in one locality (Glassboro). Cause undetermined.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common.

Horse Chestnut

LEAF SPOT (*Guignardia æsculi* Stewart). Very common.

Horse-Radish

Rot (Bacterial). Very common and very destructive in one locality (page 464).
ROOT ROT (*Thielavia basicola* B. & Br.) Common and sometimes destructive.

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common and sometimes destructive.

Lilac

MILDEW (*Microsphæra alni* (Walls.) Wint.). Very common.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Common.

Maple

TAR SPOT (*Rhytisma acerinum* (Pers.) Fr.). Occasional.
LEAF INJURIES (cold weather). Many complaints came in during the spring of 1921 concerning leaf injuries which were no doubt due to frost and unfavorable weather conditions.

Muskmelon

WILT (*Bacillus, tracheiplitis* E. F. Smith). Common and sometimes destructive.
DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and sometimes severe.
LEAF MOLD (*Alternaria brassicæ* (Berk.) Sacc.). Common and severe.

Oats

SMUT (*Ustilago levis* (K. & S.) Magnus). Common.
SMUT (*Ustilago avenæ* (Pers.) Jens.). Common.
RUST (*Puccinia coronata* C'da.). Common.

Okra

WILT (*Verticillium albo-atrum* R. & B.). Abundant in one locality.

Pea

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

ROOT ROT (*Fusarium* sp.). Very abundant and very destructive. Heaviest losses in Burlington and Cape May counties.

Peach

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Abundant and destructive.

SCAB (*Cladosporium carpophilum* Thum.). Abundant in unsprayed orchards.

LEAF CURL (*Exoascus deformans* (Berk.) Fckl.). Abundant in orchards that have not been properly sprayed.

SHOT-HOLE (*Bacterium pruni* E. F. Smith). Abundant in some localities.

MILDEW (*Podosphæria oxycanthæ* (D. C.) DeBary). One case on the fruit in May, 1921.

YELLOWS. Common.

LITTLE PEACH. Common.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Common.

WINTER INJURY. In some cases severe and dating back to 1917-18.

Pear

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Common throughout the state and severe in a few orchards.

LEAF AND FRUIT SPOT (*Fabræa maculata* Lev.). Very abundant and very destructive in some orchards, especially in the southern part of the state.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH (Cause undetermined). Common.

SCAB (*Venturia pyrina* Aderh.). Common where the orchards have been neglected.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common.

ROT (*Macrosporium* sp.). Common on fruits, especially those that have been sunburned.

MOSAIC. Common but apparently of little importance.

SUN SCALD. Common and followed by fruit rots.

LEAF FALL (Cause unknown). Cause of heavy losses.

Pine

BLISTER RUST of white pine.

Plum

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the state.

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Common throughout the state and destructive.

Potato

BROWN STEM (*Rhizoctonia*). Common but not as destructive as in previous years.

BLACK LEG (*Bacillus phytopthorus* Appel). Rare in 1920; common in 1921.

SCAB (*Actinomyces chromogenus* Gast.). Much more abundant than usual.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). Abundant throughout the state.

LATE BLIGHT (*Phytophthora infestans* DeBary). Very abundant and very destructive.

MOSAIC. Very severe in some fields of Giants.

LEAF ROLL. Rare.

TIP BURN. Common.

ARSENICAL POISONING. Common and usually due to carelessness in application.

SEED PIECE ROT (*Bacillus vulgarus*). Prevalent in some parts of the state during spring of 1921.

SPINDLING SPROUTS. Common. Probably due to several causes.

Quince

BLACK ROT (*Sphæropsis malorum* Pk.). Very abundant and very severe.

FIRE BLIGHT (*Bacillus amylovorus* (Burr) DeToni). Common.

LEAF AND FRUIT SPOT (*Fabræa maculata* (Lev.) Atk.). Abundant and very severe.

RUST (*Rostellia aurentiana* Pk.). Occasional.

Raspberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Abundant and destructive.

LEAF SPOT (*Septoria rubi* West.). Abundant but of little importance.

CANE BLIGHT (*Leptosphæria coniothyrium* Fckl.). Common and sometimes destructive.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Abundant and destructive.

Rose

ANTHRACNOSE (*Glœosporium rosæ* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosæ* (Lib.) Fr.). Common and very severe in greenhouses.

LEAF SPOT (*Phllostiata rosicola* Massal.). Abundant and sometimes confused with leaf blotch.

CANE BLIGHT (*Leptosphæria coniothyrium* (Sacc.) Fckl.). Common and sometimes serious.

POWDERY MILDEW (*Sphærotheca pannosa* (Wallr.) Lev.). Common and frequently very injurious.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Frequent and sometimes serious.

ROSE (*Botrytis* sp.). Causing a rotting of buds in the greenhouse.

Strawberry

LEAF SPOT (*Mycosphærella fragariæ* (Tul.) Lidau). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

WINTER INJURY. Occasional.

Sun-Flower

RUST (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

BLACK ROT (*Sphæronema fimbriatum* (E. & H.) Sacc.). Abundant.
STEM ROT OR YELLOW ROT (*Fusarium batatatis* Wollen. and *E. Hyperoxysporium*). Abundant and the cause of heavy losses (page 466).
SCURF (*Monilochætes infuscans* E. & H.). Very common.
ROTS (*Rhizopus nigricans* Ejr., *Diaporthe Batatatis* H. & F., *Sclerotium bataticola* Taub, *Tricoderma kœnigii* and *Penicillium* sp.). Very abundant, especially in storage.
POX (*Cytospora batata* Elliott). Occasional.
SEED-BED ROT (*Fusarium* sp.). Occasional.

Sycamore

ANTHRACNOSE (*Gnomonia veneta* (S. & S.) Kleb.). Very common; sometimes destructive in nurseries.
SUN SCALD. Several well defined cases. In some cases the trees died.

Tomatoes

LEAF BLIGHT (*Septoria lycopersici* Speg.). Abundant and very destructive (page 463).
FRUIT ROT (*Macrosporium solani* E. & M.). Common and very destructive.
ANTHRACNOSE (*Colletotrichum phomoides* (Sacc.) Chester). Abundant and very destructive.
STEM BLIGHT OR WILT (*Fusarium lycopersici* Sacc.). Abundant in one locality.
STREAK (Cause unknown). Very abundant in some fields in 1921.
MOSAIC Abundant.
LEAF MOLD (*Cladosporium fulvum* Ck.). Common in greenhouses and very severe.
LEAF ROLL (Cause unknown). Common and apparently becoming more serious.

Walnut

LEAF SPOT (*Marsonia juglandis* (Lib.) Sacc.). Abundant and cause of early fall of foliage.
BACTERIAL SPOT OF LEAF AND FRUIT (*Pseudomonas juglandis* Pierce). Abundant on English walnuts and the cause of many inquiries.

Watermelons

ANTHRACNOSE (*Colletotrichum lagenarium* (Passe.) E. & H.). Very abundant.

Wheat

RUST (*Puccinia coronata* Cda.). Common.
RUST (*Puccinia rubigovera* (De C.) Wint.). Common.
RUST (*Puccinia triticinia* Erh.). Common.
SMUT (*Tilletia fœtens* (B. & C.) Trel.). Common.
SMUT (*Tilletia tritici* (Bei.) Wint.). Common.
SMUT (*Ustilago tritici* (Pers.) Jens.). Common.
MOLD (*Cladosporium herbarium* (Pers.) Lk.). Abundant.
SCAB (*Gibberella saubinetti* (Mont.) Sacc.). Very common and destructive.

REPORT OF POTATO-SPRAYING TESTS

WILLIAM H. MARTIN

The cooperative potato-spraying tests were continued during the summer of 1920. In addition to the regular spray schedule a comparison was made of various strengths of Bordeaux mixture and the value of early and late applications of the standard 5-5-50 mixture.

Comparison of Various Strengths of Bordeaux Mixture

The soil on which this test was conducted is a Sassafras loam to sandy loam in excellent condition and well adapted to potatoes. The field was planted with home-grown Irish Cobblers. At the time of planting, 1 ton of a 4-8-3 fertilizer was applied per acre.

The purpose of this test was to compare the value of various amounts of copper for the control of tip-burn and early blight. The standard 5-5-50 mixture was compared with a 4-4-50 mixture. In both cases the sprays were applied at the rate of 100 gallons per acre. The sprayer used for this work was a traction machine, and a uniform pressure of 150 pounds was maintained for all of the work. The machine was equipped to spray 4 rows. Three nozzles were used to the row, one nozzle was directed downward while the other two were pointed inward, which plan gives a very good covering.

Five spray applications in all were made on the following dates. The first application was made on June 8 when the plants were 6 inches high. The second, third and fourth applications were made June 18 and 29, and July 9, respectively. Up until this time no foliage diseases of any kind had appeared on either the Bordeaux or the check plots. At the time of the fifth application, July 22, the plots receiving the copper sprays were still green, while the check plots were heavily infected with tip-burn and early blight. In this test the check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder per acre. In this connection the question might be raised as to whether this does not explain the relatively small increases resulting from previous spraying tests with Bordeaux mixture in New Jersey. There is little doubt but that if the check plots received the treatment given the general fields by a majority of the growers a greater difference would be observed between the so-called check plots and the treated plots. In most instances the New Jersey growers use an arsenate of lead or paris green dust for the control of insects; where the liquid is applied the pressure is usually very low and the machine is frequently equipped with but one nozzle to the row. As will be shown later in this report, thorough spraying with arsenate of lead can be expected to give an increase in yield over dusted plants and probably over those poorly sprayed.

In table 1 is given the arrangement of the plots together with the yield per acre for each plot. The last column of the table gives the number of dead leaves on the various plots on August 3. These data were obtained by making a count of the number of dead leaves on every tenth plant on the middle row of each plot.

The average yield of the plots sprayed with arsenate of lead is 260.3 bushels per acre as compared with 281.4 bushels and 266 bushels for the plots receiving the 5-5-50 and the 4-4-50 mixtures, respectively. On the basis of dead leaves from the count made August 3 there was also a difference in favor of the 5-5-50 mixture. The average number of dead leaves on the check plots was 93.3 per cent as compared with 70.3 per cent on the 5-5-50 plots and 76.3 per cent on the 4-4-50 plots.

Table 1

Comparison of Different Strengths of Bordeaux Mixture—Irish Cobbler Variety of Potatoes

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Checks	Difference	Dead Leaves on August 3
	bu.	bu.	bu.	per cent
Check—Arsenate of lead	279.5	.....	.....	92
Bordeaux mixture—5-5-50 and arsenate of lead	283.4	269.2	+14.2	76
Bordeaux mixture—4-4-50 and arsenate of lead	270.6	260.2	+10.4	76
Check—Arsenate of lead	250.6	.....	.....	93
Bordeaux mixture—5-5-50 and arsenate of lead	273.9	255.2	+18.7	68
Bordeaux mixture—4-4-50 and arsenate of lead	260.9	259.8	+ 1.1	77
Check—Arsenate of lead	264.6	.....	.....	93
Bordeaux mixture—5-5-50 and arsenate of lead	288.2	259.1	+29.1	67
Bordeaux mixture—4-4-50 and arsenate of lead	266.6	252.8	+13.8	76
Check—Arsenate of lead	246.5	.....	.....	98

These results were obtained in the absence of late blight; the increased yield as the result of spraying no doubt resulting from the control of tip-burn and early blight. Tip-burn was abundant and the difference in appearance between the plots sprayed with Bordeaux mixture and of those sprayed with arsenate of lead was greater than is indicated by the count of dead leaves.

From the results of this test, it is apparent that the use of 5-5-50 Bordeaux mixture can be expected to give better control of tip-burn and early blight than the 4-4-50 mixture.

Comparison of Early and Late Spray Applications

In the same field in which the work just reported was conducted a comparison was made of the relative value of early and late applications of Bordeaux mixture for the control of tip-burn and early blight.

The plots receiving the early applications were sprayed on June 8, 18 and 29, and those receiving the late applications on June 29 and July 9 and 22. The check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder to the acre.

The arrangement of the plots and the yield per acre are given in table 2. The average yield of the check plots was 259.4 bushels per acre, of the plots receiving the early applications 240.3 bushels per acre, and of those receiving the late applications 273.1 bushels per acre. It is apparent that the plots receiving the early applications showed a decrease of 19.1 bushels over the check plots, while those receiving the late applications showed an increase of 13.7 bushels.

As in the previous test a count of the dead leaves was made on August 3. At that time 98 per cent of the leaves on the check plots were dead, on the plots receiving the early applications 91 per cent of the leaves were dead, while on the plots receiving the late applications 75 per cent were dead.

It is interesting to compare the yield of these plots with that of the plots in the same field receiving 5 applications. The average yield of the check plots for these two tests was 260.3 bushels and 259.4 bushels, per acre, indicating that there was little difference in the soil in various parts of the field. The average yield of the plots sprayed five times with Bordeaux mixture was 281.4 bushels per acre, for those receiving the three late applications, 273.1 bushels and for those receiving the early applications 240.3 bushels per acre.

Table 2

Yield of Potatoes per Acre in Comparison of Early and Late Spray Applications, Irish Cobbler Variety

TREATMENT	Series A	Series B	Series C	Average
	bu.	bu.	bu.	bu.
Check—Arsenate of lead	242.3	249.2	245.6	245.7
Bordeaux mixture and arsenate of lead, June 8, 18, 29.....	241.3	239.3	240.4	240.3
Bordeaux mixture and arsenate of lead, June 29, July 9.....	305.4	278.3	268.4	284.0
Check—Arsenate of lead	290.3	272.9	256.3	273.1

The results of this test indicate the importance of the late applications. The superiority of the late applications no doubt arose from the fact that in this test no early blight appeared until late in the season. The early applications were no doubt washed from the leaves before the disease became prevalent, and consequently afforded little protection. On the other hand, the late applications covered the leaves with a protective film of the copper spray at a time when needed for the protection of the plant. The difference in yield between the plots sprayed three times late in the season and those sprayed five times would indicate further that it may not be essential that the early applications be made. This would lead to a considerable reduction in spraying cost, but must be the subject of further study before definite recommendations can be made.

Table 3

Arrangement of Plots and Yield per Acre of Spraying Tests with Late-Crop Irish Cobblers

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Check	Difference	Dead Leaves on October 18
	bu.	bu.	bu.	per cent
Check	166.6	.....	.....	90
Bordeaux mixture 5-5-50.....	202.6	165.4	37.2	15
Arsenate of lead	172.2	164.2	8.0	75
Check	163.0	.....	.....	95
Bordeaux mixture 5-5-50.....	193.0	162.7	30.3	5
Arsenate of lead	178.2	162.5	15.7	70
Check	162.3	.....	.....	95
Bordeaux mixture 5-5-50	202.3	.....	.....	7

Spraying Tests with the Late Crop

Spraying tests with the late crop were conducted with both the American Giant and the Irish Cobbler yarieties. In previous spraying tests with the former variety, planted in the spring, conflicting results have been secured. This year a spraying test was conducted with this variety grown late for seed purposes to determine if positive results would follow. The purposes of the test was defeated, however, in that late blight made its appearance, thus ensuring the success of the spray treatment.

Irish Cobbler Variety

The soil on which this test was conducted is a Sassafras loam in good condition. One ton of a 4-8-3 fertilizer was applied at time of planting. There were 15 plots in all, a check plot alternating between each two treated plots. As a result of the fact that there were no insects present in the field, the check plots were left without any kind of spray treatment.

The spray mixtures used were the standard 5-5-50 Bordeaux applied at the rate of 100 gallons per acre and arsenate of lead used at the rate of 6 pounds per acre. The latter material was included in the test to determine if thorough spraying with arsenate of lead would lead to increased yields over plots that had not been sprayed.

Five spray applications were made in all on the following dates, September 8, 12 and 27, and October 7 and 18. The last of September late blight was found on the unsprayed plots and by October 18 most of the leaves were dead. At that time a count was made of the number of dead leaves on each plot. On the unsprayed checks 94 per cent were dead as compared with 27 per cent on the plots sprayed with Bordeaux mixture, and 68 per cent on those sprayed with arsenate of lead.

The arrangement of the plots as well as the yield per acre is given in table 3. Unfortunately the third repeat of the arsenate of lead treatment and the last check plot was harvested before the weights could be obtained. The average yield of the unsprayed plots was 163.9 bushels per acre, of the arsenate of lead plots 175.2 bushels, and of the Bordeaux plots 199.3 bushels per acre. It will be seen that the arsenate of lead plots showed an increase of 11.3 bushels per acre over the unsprayed plots.

American Giant Variety

This test was conducted in the same field as was the one with the Irish Cobbler variety. The spray mixture used was the standard 5-5-50 Bordeaux mixture applied at the rate of 100 gallons per acre. The number of applications and the dates on which they were made were the same as for the Irish Cobbler variety.

Early in October late blight was responsible for killing the leaves. On October 18 a count was made of the number of dead leaves on each plot. On the unsprayed check plots 62 per cent were dead as compared with 12 per cent on the plots sprayed with Bordeaux mixture. The average yield of the check plots was 150.4 bushels per acre as compared with 178 bushels for the plots sprayed with Bordeaux mixture (table 4).

Table 4

Arrangement of Plots and Yield per Acre of Spraying Test with the Late Crop (American Giant Variety)

TREATMENT	Total Yield per Acre	Rotted Tubers at Time of Digging	Yield of Sound Tubers	Calculated Yield per Acre of Checks	Difference
	bu.	bu.	bu.	bu.	bu.
Check	163.0	2.4	161.6	.....	....
Bordeaux mixture 5-5-50..	184.0	.....	184.0	156.7	27.3
Bordeaux mixture 5-5-50..	199.4	.....	199.4	151.8	47.6
Check	153.1	6.2	146.9	.....	....
Bordeaux mixture 5-5-50..	166.9	.....	166.9	141.5	25.4
Bordeaux mixture 5-5-50..	161.7	.....	161.7	136.1	25.6
Check	135.3	4.6	130.7	.....	....

THE INFLUENCE OF SULFUR ON THE CONTROL OF POTATO SCAB

WILLIAM H. MARTIN

The studies resumed last year on the relation of sulfur to the control of common scab of potatoes have been continued. Experiments were conducted in the important potato-growing sections of the state on different soil types and with both American Giant and Irish Cobblers varieties. In all of the tests conducted the sulfur applications were made broadcast just before the crop was planted. The applications were made by hand or with a grain drill. The latter method proved more efficient, since a uniform distribution is assured and the sulfur is thoroughly worked into the soil.

In the experiments conducted no differences were apparent in vine growth on the plots receiving various amounts of sulfur. When the crop was harvested it was divided into three classes, namely, clean, salable and unsalable scabby. The first class consisted of all tubers free from scab. The tubers in the second class showed only a moderate infection, while those in the last class were for most part covered with scab lesions.

Soil samples were taken at the time of planting and again when the crop was harvested. The hydrogen-ion concentration of water extracts of the soil samples was determined colorometrically following the method devised by Gillespie (2). The indicators used were those recommended by Clark and Lubs (1).

This work will be reported briefly here; a more complete discussion of the results will appear in another place. The following tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent. The data given are averages obtained from at least three replications of each treatment and of four checks plots.

Irish Cobbler Variety

Experiment 1

The soil on which this experiment was conducted is a very light sandy loam. In 1919 the field was planted with the Red Skin variety of potatoes. At that time the entire crop was very scabby, a greater part of the tubers being unsalable. Sulfur applications at the rate of 300 and 600 pounds per acre were made on April 27, just before planting. The effect of the sulfur treatment on total yield and control of scab is shown in table 1.

Table 1

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(I. Kaufmann farm, Bridgeton)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	97.3	20.1	40.8	38.5	6.05
300 lbs. Sulfur†...	88.2	54.1	24.5	21.4	5.50
600 lbs. Sulfur†...	87.2	75.0	20.8	4.2	4.75

*Average of 6 plots.
†Average of 3 plots.

It will be seen from the table that the 300 and 600-pound applications show a decrease in yield of 9.1 and 10.1 bushels per acre over the adjoining check plots. It will also be seen that there was a marked gain in the number of clean tubers on the treated plots, this increase amounting to 34 and 54.9 per cent for the 300 and 600-pound applications, respectively. On the basis of unsalable scabby tubers there was a considerable decrease on the sulfured plots, the decrease being greater with the heavier applications. With the decrease in the number of unsalable scabby tubers there was a corresponding decrease in the exponent values of the soil extracts from the treated plots. At the time of planting the exponent value of the check plots was 6.3 as compared with 6.05 at the time of harvesting. The exponents of the plots receiving the 300 and 600-pound applications were 5.50 and 4.75, respectively.

Experiment 2

The soil on which this experiment was conducted is a Sassafras to sandy loam. This field was limed in 1916. Since then it has been in corn in 1916, potatoes in 1917 and 1918 and corn in 1919. In 1918 the potato crop was very scabby, approximately 30 per cent of the crop being unsalable.

Sulfur flour was applied at the rate of 300 and 600 pounds per acre just before planting. Soil samples taken from the various plots before the sulfur applications were made showed an average hydrogen-ion exponent of 6.6.

Table 2

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Alfred Sloan farm, Elmer)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	254.0	61.2	38.8	....	5.96
300 lbs. Sulfur†...	238.8	92.3	7.7	....	4.85
600 lbs. Sulfur†...	258.9	92.2	7.8	....	4.56

*Average of 6 plots.
†Average of 3 plots.

The results of this experiment are given in table 2. On the basis of total yield the plots receiving 300 pounds of sulfur per acre show an apparent decrease of 15.2 bushels over the untreated plots, while those receiving the 600-pound application show an increase of 4.9 bushels.

In this experiment there were no unsalable scabby potatoes. There was, however, a marked increase in the number of clean tubers on the plots receiving the sulfur applications, this increase being slightly greater for the plots receiving the 300-pound application. There is little difference in exponent values between the treated plots; 4.85 and 4.56 for the 300 and 600-pound applications, respectively. It is apparent from the results obtained that for this soil it was unnecessary to use sulfur in excess of 300 pounds to obtain satisfactory control of scab.

Experiment 3

The soil on which this test was conducted is a sandy loam. The field received an application of lime in 1913 at the rate of ½ ton of calcium oxide per acre. It was last planted in potatoes in 1917 and at that time there was a severe infestation of scab over the entire field. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 3

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Isaac Bacon farm, Salem)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	287.3	23.5	32.7	43.8	6.15
300 lbs. per acre†..	291.3	64.8	17.4	17.8	6.1
600 lbs. per acre†..	328.3	68.0	20.1	11.9	4.8

*Average of 6 plots.
†Average of 3 plots.

The results of this test are given in table 3. It will be seen that both the 300 and 600-pound applications gave increased yields over the check plots. As in the preceding experiments there was a considerable increase in the number of clean tubers with a corresponding decrease in the unsalable scabby tubers on the treated plots.

The initial hydrogen-ion exponent of this soil was 6.4 as compared with 6.15 for the check plots at the time of digging. It will be observed that a marked decrease in exponent values resulted on the plots treated with 600 pounds of sulfur, while the decrease on the plots receiving 300 pounds was very slight. It has been previously shown (3) that the hydrogen-ion exponent values reach their lowest level about mid-season and then tend to return to the original values at digging time. This may possibly account for the fact that while there is no apparent lowering of exponent values on the plots receiving the 300-pound application the control of scab is approximately as efficient as on the plots treated with 600 pounds of sulfur.

Experiments with the American Giant Variety

In the past the New Jersey growers have frequently resorted to growing the American Giant variety, resulting from the fact that they were considered less likely to scab than the Irish Cobbler variety. It is doubtful if this is longer true, since many fields were observed

the past several years in which the American Giant variety grew very scabby. A number of experiments were conducted with this variety this year.

Experiment 1

The field in which this work was conducted received an application of 1,700 pounds of ground limestone per acre in 1913. It was last in potatoes in 1915. At that time there was a uniform scab infection over the entire field, approximately 30 per cent of the crop being unsalable. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 4

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Wm. Patterson farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	308.8	39.9	47.9	12.2	6.22
300 lbs. Sulfur† ...	269.7	76.9	16.5	6.6	5.86
600 lbs. Sulfur† ...	316.8	90.3	9.4	0.3	4.8

*Average of 6 plots.
†Average of 4 plots.

The results of the test are given in table 4. On the basis of total yield the plots receiving the 600-pound application showed an increase of 8.0 bushels per acre over the check plots, while those receiving 300 pounds showed a decrease of 39.1 bushels. In view of the fact that the 600-pound application resulted in a slight increase it is questionable if the decrease resulting from the 300-pound application can be attributed to any injurious effect of the sulfur treatment.

Of the total yield from the untreated plots 60.1 per cent were scabby, while the plots treated with 300 pounds of sulfur and those receiving 600 pounds gave total yields of which only 23.1 per cent and 9.7 per cent, respectively, were scabby. The initial exponent of this soil was 6.4 as compared with an exponent of 6.2 at time of

digging. It will be seen that with increased applications of sulfur there were corresponding decreases in exponent values, amounting to 0.36 for the 300, and 1.42 for the 600-pound treatment.

Experiment II

This field received 2,000 pounds of hydrated lime per acre in 1916. It was last in potatoes in 1918 and 1919. At that time, while there was considerable scab, the infestation was not uniform. Sulfur applications were made at the rate of 300 and 600 pounds per acre. The results are given in table 5.

Table 5

Influence of Sulfur Applications on Total Yield and Percentage of Scabby Tubers

(I. Van Deveer farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable, but Scabby	Unsalable Scabby
	bu.	per cent	per cent	per cent
Check*	330.5	44.4	52.4	3.2
300 lbs. Sulfur†	311.6	73.9	23.2	2.9
600 lbs. Sulfur†	350.8	76.8	22.1	1.1

*Average of 4 plots.
†Average of 2 plots.

In this field the plots receiving both the 300 and the 600-pound treatment outyielded the adjoining untreated plots. While the number of clean tubers is increased on the treated plots as compared with the checks, with a corresponding decrease in the number of unsalable tubers, the differences are by no means as great as recorded for the first experiment with this variety. This may possibly be accounted for by the fact that the decrease in exponent values is not as great in this as in the other experiment, being only 0.2 and 0.4 for the 300 and 600-pound applications, respectively. This slight decrease in exponent values might be accounted for by the fact that the sulfur was not oxidized due to the absence of sulfur-oxidizing organisms. The importance of their presence to insure success following the use of sulfur for the control of scab will be discussed at another place in this report.

Experiment 3

This field received an application of lime in 1902 and a heavy application of marl in 1904. It was last planted in potatoes in 1917. At that time there was a uniform infestation of scab on the portion of the field treated with marl. Sulfur was applied at the rate of 300 and 600 pounds per acre. The results are given in tables 6.

Table 6

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Britton Cook farm, Farmingdale)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	159.8	12.0	57.8	30.2	6.3
300 lbs. Sulfur† ...	182.0	34.6	46.8	18.6	6.1
600 lbs. Sulfur† ...	170.2	40.8	45.5	13.7	5.9

*Average of 6 plots.
†Average of 4 plots.

The plots receiving the light application of sulfur showed a decrease of 18.9 bushels per acre, while the 600-pound treatment showed an increase of 20.3 bushels over the check plots. The number of clean tubers was increased from 44.4 per cent on the untreated plots to 73.9 per cent on the plots receiving 300 pounds of sulfur, and 76.8 per cent on those receiving 600 pounds. There was a corresponding decrease in the number of scabby tubers.

References

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INOCULATED VS. UNINOCULATED SULFUR FOR THE CONTROL OF POTATO SCAB

WILLIAM H. MARTIN

It will be seen from the preceding paper that while the use of commercial sulfur flour in most of the tests conducted gave very good control of scab, in others the differences in the number of salable potatoes on the treated and untreated plots was not so marked. It has been demonstrated that the biological factor is influential in the oxidation of sulfur. In view of the fact that the beneficial action from the use of sulfur results from its oxidation, the importance of the presence of sulfur-oxidizing organisms is readily apparent. It is very probable that the lack of these organisms in the soil might determine to a large extent the success or failure of sulfur to control scab. The experiments herein reported were conducted to determine to what extent this might be true.

In this work inoculated and uninoculated commercial sulfur flour were used. Inoculation was effected by means of a thorough mixing of the commercial flour with 1 per cent of soil from a compost heap known to be well supplied with the sulfur oxidizing organism. The sulfur applications were made with a grain drill just after harrowing and just before planting. The experiments were conducted with the Irish Cobbler variety. At the time of harvesting, soil samples were taken and the crop divided into classes as previously outlined.

The results of the test are given in the following tables. The data included in the tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent.

Experiment 1

The soil on which this experiment was conducted is a Sassafras loam. In 1915 an application of ground limestone was made at the rate of 3 tons per acre. Following this treatment the field was in grass in 1916 and 1917, and in potatoes in 1918 and 1919. In the latter year there was a uniform infestation of scab over the entire field, a great part of the crop being unsalable.

Both inoculated and uninoculated sulfur were applied just before planting at the rate of 300 and 600 pounds per acre. It will be seen from table 1 that on the basis of total yield the treated plots showed a considerable increase over the untreated check plots.

Table 1

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	195.0	0	6.4	93.6	7.06
600 lbs. uninoculated sulfur	229.0	10.9	37.7	51.4	6.23
600 lbs. inoculated sulfur	249.4	46.9	28.7	24.4	5.60

This increase may be accounted for in part by the fact that the tubers on the check plots were severely scabbed, none of them being free from scab lesions. On the other hand, while of those from the treated plots some were scabby, none were severely infected.

With the 600-pound applications of both the inoculated and the uninoculated sulfur there was a considerable decrease in unsalable potatoes over the adjoining check plots. This decrease amounted to 69.2 for the former and 42.2 for the latter. The benefit derived from the use of the inoculated sulfur is more clearly brought out when the number of clean tubers is considered. On the untreated plots none were clean as compared with 10.9 per cent for the plots treated with the uninoculated, and 46.9 per cent for those receiving the inoculated sulfur.

The plots receiving the inoculated sulfur showed a greater decrease in hydrogen-ion exponent values than those treated with the uninoculated sulfur. This decrease amounted to 1.45 for the former and 0.83 for the latter.

The plots treated with 300 pounds of sulfur likewise show a lower percentage of scabby tubers than the untreated plots. Of the total yield from the untreated plots, 58.3 per cent were unsalable scabby while the plots treated with inoculated and uninoculated sulfur gave a total yield of which 29.4 per cent and 57.4 per cent, respectively, were unsalable.

Table 2

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	183.1	9.4	32.3	58.3	6.6
300 lbs. uninoculated sulfur*	254.3	13.1	29.5	57.4	6.3
300 lbs. inoculated sulfur*	288.7	34.1	36.5	29.4	6.0

*Average of 3 plots.

From the table it will be seen that the plots receiving 300 pounds of inoculated sulfur showed greater decreases in exponent values than those receiving the uninoculated sulfur.

It is interesting to note that the decrease in exponent values indicated for the plots treated with 300 pounds of inoculated sulfur was nearly as large as for the plots treated with 600 pounds of uninoculated sulfur. The latter showed a reduction of 42 per cent in the number of unsalable scabby potatoes as compared with 28.9 per cent for the former, a difference of only 13.3 per cent in favor of the heavier applications.

Experiment 2

The soil on which this experiment was conducted is a Penn loam that had not been planted in potatoes for a number of years. To insure the presence of the scab organism in the soil untreated scabby seed was planted. Sulfur at the rate of 900 pounds per acre was broadcasted by hand just before planting. The results are given in table 3.

Table 3

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(College farm, New Brunswick)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	78.0	43.2	34.4	22.4	6.6
900 lbs. uninoculated sulfur	60.2	69.3	15.4	15.3	4.6
900 lbs. inoculated sulfur	78.2	81.4	17.1	1.5	4.7

On the basis of total yield there was only small difference between the check and the treated plots. As in the preceding experiments there was a marked reduction of unsalable scabby tubers on the plots treated with inoculated sulfur with a much smaller reduction on the plots treated with the uninoculated sulfur. The increase in the percentage of clean potatoes was likewise greater for the inoculated sulfur, amounting to 38.2 per cent as compared with 26.1 per cent for the uninoculated sulfur.

Soil samples taken before the sulfur applications were made showed a mean value for all of the determinations of 6.61. The exponent of the check plots at time of harvesting was 6.6. The values of the hydrogen-ion exponents of the soil samples corresponding to the two treatments show a considerable decrease over those of the check plots, being 4.6 for the plots receiving the uninoculated sulfur and 4.7 for those treated with the inoculated sulfur. While the exponent values for the two treatments are approximately identical, it will be seen from the table that the number of unsalable tubers was reduced from 15.3 per cent recorded for the plots treated with uninoculated sulfur to 1.5 per cent for those receiving the inoculated sulfur.

THE FERTILIZER VALUE OF SULFUR FOR POTATOES

WILLIAM H. MARTIN

Conflicting results have been secured in the field regarding the effect of sulfur applications on the yield of potatoes. In some of the tests, plots receiving as many as 600 pounds of sulfur per acre showed marked increases over adjoining untreated check plots. In other cases an application of 300 pounds per acre resulted in decreased yields. In order that more definite information might be had on this question, experiments were conducted in the greenhouse during the winter of 1919-20. The original plan of this work was to study the effect of sulfur treatments on both scab control and yield. The soil on which the work was conducted proved too acid, however, to allow for the development of the scab organism. For this reason the experiment was limited to a test of the effect on yield.

In this work two methods of applying the sulfur were adopted. In one case it was broadcasted and thoroughly worked into the surface soil just before planting. Three amounts were applied in this manner, namely, 200, 400 and 600 pounds per acre. The second method consisted of mixing sulfur with the fertilizer. Applications were made at the rate of 100, 200 and 300 pounds per acre.

The floor of the greenhouse in which this work was conducted was divided by cement partitions into 28 compartments, each 3 feet deep and containing 7.5 square feet Seven series were included in the experiment. Each series consisted of a check plot with three treated plots. To eliminate, as far as possible, any differences that might arise from variation in the size of the seed-piece and in the yielding power of different tubers, each seed potato was cut into four equal pieces, the cut being made through the stem and bud end. One of the quarters was then planted in each of the four plots of a series. In case of the broadcasting method each series was repeated four times while there were three repeats of the sulfur-fertilizer mixture.

Each of the 28 plots received a uniform application of a 4-8-3 fertilizer at the rate of 1,800 pounds per acre. Half of the ammonia was derived from nitrate of soda, and the remaining half from ammonium sulfate. The phosphorus and potash were derived from phosphoric acid and muriate of potash.

The moisture content of the various plots was maintained as nearly uniform as possible. Before the sulfur applications were made and again at weekly intervals until the crop was dug, soil samples were taken and the hydrogen-ion concentration of soil extracts determined colorimetrically.

The effect of the two methods of applying the sulfur on yield and hydrogen-ion concentration is given in the tables following.

Sulfur in Combination with the Fertilizer

The effect of mixing sulfur with the fertilizer on yield and exponent values is given in table 1. It will be seen from the table that the addition of 100 pounds of sulfur to the fertilizer had no injurious effect, the yield of these plots being 3.4 bushels more than that of the check plots. The addition of 300 pounds of sulfur to the fertilizer brought about a decrease of 18.7 bushels over the check plots. A still greater difference, amounting to 75.3 bushels per acre, resulted from the fertilizer mixture containing 500 pounds of sulfur. It is apparent from the results secured that while a fertilizer mixture containing 100 pounds of sulfur can be used without danger of injuring the crop, any amount in excess of that can be expected to lead to a reduced yield.

Table 1

Effect of Sulfur in the Fertilizer on Yield and Hydrogen-ion Concentration

Treatment	Yield per Acre*	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	285.8	5.0	5.1	+0.1
100 lbs. sulfur in the fertilizer	289.2	5.1	4.8	—0.3
300 lbs. sulfur in the fertilizer	267.1	5.6	4.9	—0.7
500 lbs. sulfur in the fertilizer	213.5	5.53	4.7	—0.83

* Average of 3 plots.

From table 1 it will be seen that the original hydrogen-ion exponent values of soil samples from the various plots included in this test were low. The initial exponent value of the check plots was 5.0 as compared with 5.1 at digging time. It will be seen from the table that with increased amounts of sulfur there were corresponding decreases in the exponent values, the greatest decrease, 0.83, resulting from the use of 500 pounds of sulfur. It will be observed also that, with the exception of the 100-pound treatment, with a decrease in exponent values below that of the check plots, there was a corresponding decrease in yield.

Sulfur Broadcasted Before Planting

The effect of broadcasting sulfur on total yield and hydrogen-ion concentration is shown in table 2. It will be seen that the 200 and 300-pound applications gave slightly increased yields over the check plots. These increases, amounting to 4.2 and 1.9 bushels, are so small, however, as to be well within experimental error so that no statement can be made as to the beneficial effect of the sulfur. It is evident, however, that for the conditions under which this work was conducted an application of 200 and 400 pounds of sulfur produced no injurious effects. The yield of the plots receiving 600 pounds of sulfur, on the other hand, was 6.5 bushels less than that of the check plots.

Table 2

Effect of Sulfur Broadcasted on the Yield of Tubers and on Hydrogen-ion Concentration

Treatment	Yield per Acre	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	255.9	4.82	4.8	—0.02
200 lbs. sulfur broadcasted	260.1	4.65	4.6	—0.05
400 lbs. sulfur broadcasted	257.8	4.67	4.4	—0.27
600 lbs. sulfur broadcasted	249.4	5.0	4.4	—0.60

From table 2 it will be seen that the initial pH value of soil samples from the check plots was 4.82 as compared with 4.8 at the time of digging. The plots receiving the 200 and 400-pound applications showed very little change in exponent values. The largest decrease resulted from the 600-pound application. It is interesting to note in this connection that the decrease in exponent values resulting from broadcasting 600 pounds of sulfur is 0.6 as compared with a decrease of 0.7 recorded for the plots receiving 300 pounds of sulfur mixed with the fertilizer. This possibly accounts for the fact that in some of the early experiments a reduction in yield followed the use of sulfur for the control of scab. In some of these earlier tests sulfur was applied at the rate of 600 pounds per acre in the row. Applied in this way the acidity produced would be so great as to interfere with the proper development of the potato crop.

STUDIES OF THE RELATION OF MATURITY TO VIGOR IN SEED POTATOES

WILLIAM H. MARTIN

The successful potato grower of today realizes the importance of planting only vigorous seed in order that maximum yields may result. This demand on the part of the grower for high-grade seed has resulted in the establishment of seed-potato certification in many of the important seed-growing sections. The purchase of seed potatoes certified to be relatively free from disease goes a long way toward solving the problem of securing the best seed. Freedom from disease alone is not sufficient, however, to insure tubers of highest vigor. The question of maturity is one of considerable importance, since it has been frequently demonstrated that immature tubers possess more vitality than mature tubers and consequently are more desirable for seed purposes.

As early as 1849 Wilson (4) stated, "Green tubers, or tubers which have never ripened to dryness, are, in all circumstances, the best." Sweet (3) states that the remark is made of Sir Matthew Wallace, a prominent English potato grower, that, "he is without exception using partially grown or partially mature seed. The potates that are lifted in July are kept over until the next March for planting. He claims that he gets less disease than when lifted at maturity, the potato throws out a less number of sprouts when planted, it makes a more vigorous growth and the sprout is stronger. Consequently, the crop ripens earlier." The Department of Agriculture of Ireland likewise points out that "seed potatoes from crops lifted before they fully mature will produce more vigorous plants, and, consequently, heavier yields than seeds from crops which have become mature."

In a series of experiments conducted at Wye and at the Midland Agriculture College, Hutchison (1) demonstrated the advantage of immature over mature tubers for seed. He states that the superiority of immature tubers may be due to four causes; (a) the method of selection, (b) the structure of the tuber coats, (c) the amount and condition of the reserve food materials and (d) the length of the time in storage. Hutchison suggests that the best practice to follow in obtaining immature seed is to plant at the usual time of the year and raise the crop early rather than plant in the late summer or early fall.

Macoun (2) planted potatoes at 14-day intervals starting May 22, the last planting being made July 3. The tubers from the various lots were planted on the same date the following year. In most every instance there was an increase in yield from the earliest to the latest plantings, indicating that the most immature seed could be expected to give the largest yield. In another test he harvested seed immature from an early planted crop. The following year this immature seed gave pronounced increases in yield when compared with mature seed of the same variety.

In New Jersey two methods of obtaining seed potatoes are commonly followed. The first, and more important, consists in planting

not earlier than July 15 and not later than August 20. By planting at this time of the year the vines are usually growing vigorously when killed by frost, thus ensuring seed that has not matured. Among the local growers the last planted is considered the best for seed, probably resulting from the fact that this seed is more immature than seed from the earliest plantings. The second method consists of harvesting tubers immature from the main crop while the vines are still green. In the past it has not been definitely known at what stage in the development of the plant this should be done in order to obtain seed of the highest vigor. The studies here reported were undertaken with the idea of determining if possible the best time to harvest tubers from the main crop for seed purposes as well as to determine the relation between mature and immature seed with regard to vigor.

Experimental Procedure

In 1919 an area of 1/20 acre was planted with the Irish Cobbler variety to serve as a seed plot. The seed used for planting this plot was selected for uniformity and freedom from disease in 1918. The plants in the seed plot made a vigorous growth and were free from disease. At weekly intervals beginning two weeks after blossoming and continuing until the tops were dead, 15 hills were harvested. The hills harvested were selected for uniformity as to both size and appearance, especially with regard to the maturity of the vines. As each lot was harvested the weight of the individual hills was obtained. They were then placed in a well ventilated cellar until fall when they were removed to a cold-storage plant. The dates on which the various lots were dug, together with the yields per acre and the condition of the tops at the time of digging are given in table 1.

Table 1

Yield of Cobblers Dug at Intervals During the Period of Development

Date of Digging 1919	Yield per Acre	Condition of Plants
	bu.	
July 9	124.9	Two weeks after blossoming
July 17	156.5	Plants green, vigorous
July 24	207.4	24 per cent of the leaves dead
July 31	258.3	50.4 per cent of the leaves dead
August 8	281.3	91.5 per cent of leaves dead. Stems still green
August 16	280.9	Leaves and stems dead

It will be seen from the table that in a 37-day period, over which the work was conducted, there was a gain of 156 bushels per acre in total yield. The greatest weekly increases were noted for July 17-24 and for July 24-31, a gain of 50.9 bushels resulting in each of these time periods. It will be observed also that this period of greatest tuber development occurred between the time the tops began to die and when 50 per cent of the leaf surface was dead. It is interesting to note that in the time period from August 8 to August 16, that is, from the time 91.5 per cent of the leaves were dead until the stems and leaves were dead there was no increase in tuber development.

In the spring of 1920 the seed was removed from the storage house and treated for 1 hour in a solution of mercuric chloride made up at the rate of 4 ounces of the crystals to 30 gallons of water. When the seed had dried it was cut into uniform pieces, each weighing 1 ounce. In so far as possible the number of eyes was kept uniform on the various seed-pieces. The soil on which this experiment was conducted is a Penn loam. At the time of planting, April 20, an application of 1,800 pounds of a 4-8-3 fertilizer was made in the row. A plot consisted of 20 hills and to eliminate as far as possible the error arising from the use of a plot this small, each treatment was repeated six times.

While there were no marked differences in the time of germination of the various plantings, the immature tubers tended to be slightly ahead of those that were mature. As the season advanced, marked differences became apparent in the size and general vigor of the plants on the various plots.

Table 2

Height of the Vines in 1920 and Rainfall in 1919

Date Dug, 1919	Series 1	Series 2	Series 3	Series 4	Series 5	Series 6	Average	Rainfall, 1919
	in.	in.	in.	in.	in.	in.	in.	in.
July 9.....	12.5	12.7	12.9	12.9	13.3	13.0	12.9	July 2-9 1.25
July 17.....	10.1	10.5	11.8	11.0	10.8	12.6	11.1	July 10-17 1.83
July 24.....	13.0	13.2	13.4	11.7	12.8	10.6	12.4	July 18-24 5.02
July 31.....	11.7	11.9	11.9	12.0	10.9	11.2	11.6	July 25-31 0.23
August 8.....	10.7	11.1	11.2	10.0	11.1	10.9	10.8	July 31-Aug. 8 0.39
August 16.....	9.8	9.1	10.1	9.6	9.2	9.6	9.6	Aug. 9-Aug. 16 2.75

On June 14 the measurement of each plant was obtained. The average for each of the six plots is given in table 2.

It will be seen from the table that with the exception of the seed dug on July 24, 1919, there was a fairly uniform decrease in the height of the vines with increased maturity in the seed-piece. The average of the six duplications is given in the second to the last column of the table. It will be observed that the vines from the seed dug July 17 are smaller than those from seed dug a week later, the average height being 11.1 and 12.4 inches, respectively.

In this connection it is interesting to examine the precipitation records for 1919 for the time periods during which the seed was dug. These data are included in the last column of table 2. For the period July 2-9 and July 10-17 there was a rainfall of 1.25 and 1.83 inches, respectively, as compared with 5.02 inches for the period from July 18 to 24; of this amount, 3.25 inches fell the first three days. This excessive rainfall, coming at a time when tuber development was at its maximum, doubtless led to a rapid soft growth of the tuber so that the texture of the cortical layer was probably as immature as was that of the tubers dug July 9. This fact may possibly account for the differences noted in vine growth in 1920. This is in accordance with the view expressed by Hutchison (1). In explaining the superiority of immature over mature seed he states that, "the contex of immature tubers is thinner, less firmly attached and capable of being more easily ruptured than that of mature tubers. The character of the tuber coat varies with different varieties, and also in the same variety when grown under different conditions of soil and climate. Warm, dry soils favor this development and tubers grown on such land are unsuitable for seed."

These differences in the appearance of the vines of the various plots were maintained throughout the growing season.

Table 3 gives the average yield of the various plots, including primes and seconds as well as the total yields.

Table 3

Relation of Immature Seed to Yield and to Percentage of Primes

Date dug in 1919	Primes per Acre	Seconds per Acre	Total Yield per Acre	Proportion of Primes
	bu.	bu.	bu.	per cent
July 9	222.6	48.2	270.8	82.2
July 17	207.6	52.3	259.9	79.8
July 24	192.6	57.1	249.7	77.1
July 31	189.4	53.9	243.3	77.7
August 8	165.4	50.4	215.8	76.6
August 16	156.2	43.8	196.4	77.7

On the basis of total yield the greatest returns were had from the plots planted with immature seed. With each increase in maturity there was a corresponding decrease in yield, the lowest yield being recorded on those plots planted with seed that had matured before being dug. Between the most immature seed, dug July 9, and that dug August 16, when the vines had died, there was a difference of 74.4 bushels per acre. The yield of the plots from tubers dug July 24 was not as great as from those dug July 17, despite the fact that vines on the former plots were larger than those on the latter.

Except for the plots planted with the most immature seed there was little variation in the number of second-prize tubers. The former plots gave a total yield of which 82.2 per cent were primes as compared with 79.8 per cent for the seed dug July 17. Of the remaining plots those planted with seed dug July 24 and 31 showed 77.1 and 77.7 per cent, respectively.

From the results of the studies here presented it is apparent that the more immature the seed the greater will be the yield of marketable potatoes. It is questionable if the use of tubers from plants that have matured or which have died prematurely for seed purposes will give satisfactory results. In selecting tubers to be used for seed they should not only be free from disease but should be immature. Disease-free plants of low vigor cannot produce a maximum crop.

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CELERY DISEASE INVESTIGATIONS

R. F. POOLE

This department has been investigating the cause and methods of control of celery root rots on muck soil areas of Bergen County for a number of years. Losses, due to *Bacillus carotovorus, Sclerotinia libertiana,* and nematodes have been very severe, especially when infected soil was cropped with Golden Self-Blanching varieties of celery. The heaviest losses occur under high temperature and moisture conditions, which are favorable for the development of these organisms. Green varieties are not severely attacked by *Bacillus carotovorus.* All varieties are susceptible to *Sclerotinia libertiana.*

Two methods of controlling root-rot diseases have been pursued in the field: application of chemical compounds as soil disinfectants and selecting for disease-resistant Golden Self-Blanching celery varieties. High-priced chemicals in the past few years made it necessary to discontinue the former part of our investigations. A very good supply of celery seed was produced last year from plants, which seemed to be resistant to *Bacillus carotovorus.* The plants were transplanted in the greenhouse from a muck farm. The seed is being tested this year on the infected muck soils.

Damping-off of seedling celery plants of all varieties in greenhouses has caused heavy losses, where plants were being grown for April and May plantings. This trouble is due to the well known fungus, *Sclerotinia libertiana,* which causes lettuce drop and damping-off of many other vegetables and plants. Rotating celery and lettuce has spread this fungus on cultivated areas. The temperature and moisture conditions of greenhouses are ideal during early spring for the development of this fungus. Several thousand plants are sometimes destroyed in a few days. The disease is first observed as a wet, soft rot near the ground. The plants later fall over, and a flocculent white mass of the fungus will appear on the leaves which fall next to the ground. This white growth produces the *sclerotia,* which are small, hard black bodies that remain in the soil until next spring and give rise to a new crop of the fungus.

For the control of this disease some very good results have been obtained by sterilizing infected muck soil in greenhouse beds with formaldehyde. Table 1 gives the results of work done this spring.

Table 1

Effect of Formaldehyde as a Control for Damping-Off of Celery

No.	Formalin	Water	Control
	pts.	gals.	
1	3	25	Poor
2	4	25	Poor
3	6	25	Poor
4	3	50	Complete
5	4	50	Complete
6	6	50	Complete

This sterilization was done in a greenhouse which had concrete beds. The soil was slightly moistened before applying the formaldehyde. The applications on the first three plots produced no noticeable control. The amount of water applied was not sufficient to saturate the soil thoroughly. When 25 gallons more of water was applied to these same strengths, making 50 gallons, it was sufficient to saturate the soil, and completely control the organism. It is advisable that care be taken in selecting soil for the greenhouse beds from fields which have not been cropped in lettuce for three or more years. This soil should be sterilized with formaldehyde (3 pints of commercial formalin to 50 gallons of water applied at the rate of 1 gallon to the square foot). Enough water must be applied to saturate the soil. Precaution is necessary to prevent reinfection after the beds are sterilized.

The diseases of celery will be taken up more fully in a bulletin which will be issued within the next year.

REPORT OF SPRAYING TEST AT CAMPBELL'S SOUP FARMS

R. F. POOLE

Spraying for the control of tomato leaf spots and other diseases has already received a good deal of attention by the plant pathology department on the Campbell's Soup Farms, near Riverton. No satisfactory results have as yet been obtained to show any advantage to be gained by spraying, nor to enable this department to recommend a specific spray schedule for tomatoes in the state. The work this year has been a continuation of the work already reported in annual reports from this station by Dr. W. H. Martin, and in Bulletin 345.

Spray applications were made July 9 and August 1 and 14, respectively. Pickings were made September 1 and 13, and October 1, 1920. A rainy season was a factor in preventing higher yields. Table 1 presents some of the results.

Table 1

Results of Tomato Spraying Tests

No.	Treatment	First Picking Sept. 1	Second Picking Sept. 13	Third Picking October 1	Total Yield per Acre
		lbs.	lbs.	lbs.	lbs.
1	Check	568.12	2474.50	429.25	5362.50
2	Bordeaux 4-4-50	1111.00	3181.50	505.00	7406.00
3	Bordeaux 0.5-0-3-50..	1237.25	4166.25	404.00	8966.00
4	Check	883.75	3307.75	429.25	7136.60
5	Bordeaux 4-4-50.....	833.25	4671.25	454.50	9204.00
6	Bordeaux 0.5-0-3-50..	580.75	2474.50	479.75	5450.00

This work will be continued. The effects of Bordeaux dust on the control of tomato leaf spots and fruit rots will be given some attention next year.

Other diseases of tomatoes have been reported to this department. The Fusarium wilt has caused a good deal of damage in some fields. The streak disease was very severe during the late summer. Anthracnose was very common on late tomatoes.

INVESTIGATION OF HORSE-RADISH ROOT ROTS

R. F. POOLE

The investigation of horse-radish root rots was carried out somewhat in accordance with the work outlined in last year's report. We have learned that the most important problem to be considered in this work is an improvement of storage conditions. The rot organism spreads rapidly in the storage pits, and it is here that the infection is most severe. The temperature and moisture conditions become favorable in the spring for the development of the rots, just previous to planting time. Large roots carried over winter in storage pits for sale are more susceptible to rots than are the smaller roots, stored for seed purposes.

Presence of the Disease in the Field

Several horse-radish farms were visited during the summer and actual counts made of the number of misses in the field. Seed roots in many cases failed to germinate due to rots and this resulted in many misses. Table 1 shows the results of an inspection in August, 1920.

Table 1

Stand of Horse-Radish on Four Farms in August, 1920

Farm	Number of Plants Counted	Number	Misses
			Per cent
1	1835	271	12.9
2	1000	270	21.3
3	2000	126	5.9
4	1305	182	11.7

Less than 1 per cent of the roots which had germinated and were growing became diseased in the field.

Control Tests

Sulfur applied at the rate of 432, 648, 972 and 1080 pounds per acre and hydrated lime applied at the rate of 1080, 2160 and 2700 pounds did not affect the yield in any way. The amount of disease on the areas to which these compounds were applied was small and no disease control due to these mixtures could be estimated.

Roots selected at digging time became diseased very similar to unselected roots, when they were stored in the pits. Careful selection of seed roots in the spring at planting time, and soaking them in corrosive sublimate or formaldehyde solutions showed that the number of misses in the field could be reduced by proper selection and treatment. Table 2 gives the results of the test.

Table 2

Effect of Cutting Horse-Radish Roots to Control Rot

Number	Treatment		Time of treatment	Number of roots soaked	Number	Misses
	Material	Strength	Minutes			Per cent
1	Formaldehyde ..	3 pt. (Commercial formalin) to 50 gal. water	60	364	46	11.5
2	Formaldehyde ..	3 pt. (Commercial formalin) to 50 gal. water	30	743	65	8.0
3	Corrosive Sublimate	1 to 1000.....	20	481	25	4.9
4	Corrosive Sublimate	1 to 1000.....	10	488	33	6.3
5	Selected root	Both ends cut; those showing any discoloration were thrown out	..	1211	99	7.6
6	Check	No treatment	..	1305	182	12.2

The results of this experiment indicate that roots should be carefully selected for planting. Both ends should be cut, and those showing a disease discoloration sorted and thrown out. The selected roots should then be soaked in a corrosive sublimate solution as used above, dried and planted. This work will be continued, and storage conditions will be given more attention.

It is hoped that this work will be sufficiently advanced during the coming year so that it can be published in bulletin form.

INVESTIGATION OF SWEET-POTATO DISEASES

R. F. POOLE

Since July, 1920, a very thorough investigation has been made of the sweet-potato disease situation in the state. Inspections were made in order to ascertain the extent of loss due to "stem rot," "black rot," "soil rot," "scurf," and other field diseases, and also to locate severely infested fields of these diseases for experimental work. Storage houses also were inspected in several counties during the winter. These inspections have given us a very good view of the amount of experimental work needed along lines of sweet-potato disease control, both in the field and in the storage house. They have also aided us in locating severely infested areas of the different diseases, which are most suitable for making control tests.

Stem-Rot Control Work

For several years "stem rot" has caused heavy sweet-potato losses in this state, especially in Gloucester County. At digging time in 1919 the county agent of Gloucester County and the writer selected 21 bushels of sweet potatoes by splitting the vines, and throwing out all those that showed discoloration due to the "stem rot" organisms. In the fields where the selection was made, 33 per cent of the sweet-potato vines were infected with stem rot. The potatoes were stored under normal conditions in a storage house at Swedesboro. The selected seed was sorted at bedding time and specimens showing diseases (less than 5/8 bushel) were thrown out. The potatoes were soaked from 8 to 10 minutes in a bichloride of mercury solution (1 to 1000). After soaking they were immediately bedded in a flue-heated hot-bed. Before bedding the potatoes the bed was thoroughly cleaned, salt-hay placed over the flooring, and about 3 inches of clean sandy soil added. After the potatoes were laid in the bed, they were covered with 3 inches of clean soil. The sprouts were grown by John Hunt, a very capable sweet-potato grower at Swedesboro.

On May 26 the sprouts were pulled and equally divided among 5 sweet-potato growers, each getting about 4,000 plants. These plants were kept separated from those grown by the growers, but were planted in the same field in order to get some comparison. Three inspections were made during the summer. The total number of plants and those diseased with stem-rot were counted. Table 1 gives the results.

Table 1

Results of Sweet-Potato Stem Rot Disease Control Experiments in Gloucester County

Experiment No.	Selection	Total Plants Counted July 22	Diseased Plants July 22	Total Plants Counted August 23	Diseased Plants August 23	Diseased Plants September 28
			per cent		per cent	per cent
1	Experiment Station.....	4144	1.88	4144	3.19	5.08
	Grower	1543	2.85	4043	6.30	8.70
2	Experiment Station.....	2819	4.61	2819	4.90	11.20
	Grower	1206	4.47	2814	6.20	14.65
3	Experiment Station.....	2626	3.38	2626	5.20	11.60
	Grower	1170	5.81	2473	6.90	14.00
4	Experiment Station.....	3413	5.27	3413	9.70	20.70
	Grower	1164	4.81	3145	14.70	30.20
5	Experiment Station.....	3389	1.41	3889	1.70	3.60
	Grower	1316	1.36	3947	2.30	3.90
6	No treatment.....	....	....	1100	26.00	51.00

These experiments were made to determine if the stem-rot disease can be reduced. Sweet potatoes actually infected with the "stem rot" were not bedded to compare with those selected. There are sufficient data available to show that heavy infection of "stem rot" occurs when carelessly selected sweet-potato seed is taken from an infected field. This is the result of one year's experimental work. The data given show favorable control results for one season, and the tests will be continued another year along the same line.

There are many climatic and seasonal differences in the counties in which sweet potatoes are grown in this state and there is more "stem rot" in some counties than in others. Sweet potatoes were selected at digging time in several of the other counties, treated and bedded according to the program followed in Gloucester County. This will give us further data on "stem rot" control.

Other Experiments

A very extensive experiment for the control of "soil rot" has been arranged in Gloucester County in cooperation with the extension division and the county board of agriculture. Sulfur, lime, acid phosphate, nitrogen and potash in varying strengths have been applied to an area on which 85 per cent or more of the total roots were infected with soil rot at digging time. The plots are sufficiently large, and should show average results. This experiment covers more than 3 acres and will require a good deal of time.

Inspections at digging time showed that 50 per cent or more of the potatoes harvested in New Jersey were affected with soil stain, also known as "scurf." This disease was very severe when manure and other organic matter were applied in the row or in the hill. Several experiments have been arranged to find out definitely how the disease is disseminated and to study control methods.

Black rot has been severe on some farms. Seed was selected at digging time in the infected fields. Potatoes selected for seed were soaked 10 minutes in a bichloride of mercury solution (1 to 1000) and bedded in a sanitary hot-bed. Close observation will be taken of the spread of the disease in the field.

Up to this time investigations of stem-rot control have been confined to Gloucester County. This year attention is being given to the Fusarium wilt in most of the southern counties at the request of growers from Atlantic, Camden and Burlington counties. Severe cases of black-rot infection have been called to our attention. The practice of selecting seed at digging time, treatment at bedding time and growing sprouts under sanitary conditions, is receiving a good deal of attention.

The results on the control of stem rot are very largely due to the work of Dr. L. L. Harter, of the U. S. Bureau of Plant Industry, and L. A. Cooley, county agent of Gloucester County. The latter has devoted a good deal of attention to the work along with the writer.

STUDIES ON EGGPLANT WILT

C. M. HAENSELER

The eggplant growers of southern New Jersey have suffered serious losses for many years due to the eggplant wilt caused by a species of *Verticillium*. Very little experimental work has been done on the eggplant wilt and consequently little is known about this disease except the knowledge gained by observations. There has even been some uncertainty as to the identity of the causal organism.

Some experimental studies were carried out during the spring and summer of 1920 to determine (a) the species of organism causing the eggplant wilt in New Jersey and (b) the time and manner of infection.

A number of collections of wilted eggplants were made in the fall of 1919 and examined for possible wilt organisms. All the plants showing characteristic wilt symptoms revealed the presence of a fungus growth in the vascular tissue when examined microscopically in cross-sections. The fungous hyphæ were noted in the secondary roots, primary roots, the main stem and the secondary branches to within a few inches of the growing tip. No hyphæ were found in the pedicel of the fruit.

Tissue cultures were made from a number of plants, the ordinary precautions being taken to prevent contamination. Pure cultures of *Verticillium albo-atrum* were obtained in almost every case.

Inoculation experiments with the isolated organism were carried out as follows:

The soil in two flats was thoroughly sterilized with formaldehyde (3 pints of formalin to 50 gallons of water) and allowed to dry for 10 days. One of these flats was heavily inoculated with a spore and mycelium suspension of *V. albo-atrum* and the other was left uninoculated. Both flats were seeded with eggplant seed of the American Black Beauty variety. When the seedlings were 5 weeks old they were "spotted" into a transplant bed as would ordinarily be done in farm practice. This transplant bed had been sterilized with formaldehyde and after drying, one-half was inoculated heavily with *V. albo-atrum*. The seedlings from the sterile seed-bed were set into the transplant bed, one-half into the inoculated portion and one-half into the sterile portion. Likewise the seedlings from the inoculated seed-bed were transplanted, part into inoculated and part into the sterile soil.

When the plants were about 4 to 5 inches high they were set into the field on a plot of ground which had not grown eggplants previously. One month after transplanting into the field one-half of the plants were inoculated with *V. albo-atrum* by puncture just below the ground level.

If we designate those plants which were from the inoculated seed-bed by *S*, those from the sterile seed-bed by *s*, those from the inoculated transplant bed by *T*, those from the sterile transplant bed by *t*, those which were puncture-inoculated in the field by *F*, and those which were not puncture-inoculated in the field by *f*, we have the following group of treatments with 10 plants to each group:

stf. Sterile seed-bed, sterile transplant bed, not puncture-inoculated.
stF. Sterile seed-bed, sterile transplant bed, puncture inoculated.
Stf. Inoculated seed-bed, sterile transplant bed, not puncture-inoculated.
StF. Inoculated seed-bed, sterile transplant bed, puncture-inoculated.
sTf. Sterile seed-bed, inoculated transplant bed, not puncture-inoculated.
sTF. Sterile seed-bed, inoculated transplant bed, puncture-inoculated.
STf. Inoculated seed-bed, inoculated transplant bed, not puncture-inoculated.
STF. Inoculated seed-bed, inoculated transplant bed, puncture-inoculated.

The plants were carefully observed during the summer for symptoms of wilt. Typical wilt occurred only in a very few plants but the effects of the disease were shown in most of the inoculated plants by a slow growth, small fruit and a premature dying of the oldest leaves. One of the 10 check plants (*stf*) suddenly developed a very severe case of typical wilt between September 10 and 15, but the other 9 plants remained in the prime of condition until frost.

The plants inoculated in the seed-bed only (*Stf*) or in the transplant bed only (*sTf*) were not seriously affected but showed some signs of disease in a number of plants.

The plants inoculated both in the seed-bed and the transplant bed (*STf*) showed slightly more dwarfing and a more rapid dying of the old leaves.

The most severe effects were gotten in the plants puncture-inoculated in the field (*stF, StF, sTF* and *STF*). All of these plants showed severe dwarfing due to the inoculation, and also bore a poor crop and lost the old leaves prematurely. But in spite of these injurious effects there was no typical wilting, the tips remaining in a growing condition until frost. Plants wounded by puncture but not inoculated showed no ill effects whatever.

Table 1 shows the average height of the 10 plants of each group, the measurement being the distance from the ground level to the end of the main branch.

Table 1

Height of Eggplants Receiving Different Treatments

Plant Group	Height	Relative Height
	in.	
stf.	28.7	100.0
stF.	23.7	82.6
Stf.	26.6	92.7
StF.	23.1	80.5
sTf.	27.6	96.2
sTF.	23.7	82.6
STf.	26.2	91.3
STF.	23.7	82.6

Although there are noticeable differences shown in this table, these differences were much more conspicuous in the field, due to the premature dying of the oldest leaves on the diseased plants. There was also a difference in the size of the main stem in the inoculated and the uninoculated plants. For example, the average diameter of the 10 check plants (*stf*), 1 inch above the ground level was 19.2 mm. The ten plants in the adjacent row, which were puncture-inoculated in the field (*stF*) had an average diameter of 14.4 mm., a difference of 4.8 mm. in favor of the uninoculated plants.

Microscopic examinations of every plant in the 8 lots were made to determine whether or not a vascular mycelium could be located. The check plants (*stf*) showed only one plant with a vascular fungus, and with the exception of this plant the wood was healthy and light-colored. Eighty-eight per cent of the inoculated plants showed a darkening of the vascular bundles and 61 per cent of the inoculated plants showed a vascular fungus by microscopic examination. It was noted that a plant which showed a premature dying of the old leaves, a dwarfing of the plant and a darkening of the vascular tissue frequently failed to show the presence of a mycelium in the vessels. This was also noted in material collected in the field. Whether the fungus in these cases had disintegrated or whether it was localized in some part of the plant was not determined. Frequently a badly diseased plant showed only traces of the organism in the vascular system and in such cases it was difficult to account for the wilting on the ground that the water supply had been cut off by the clogging of the tracheary tubes, an explanation that is generally given for the vascular "wilts."

A duplicate of the above test was carried out in another field where eggplants had been grown a few years before. All of the plants in

this test developed wilt symptoms, no differences being apparent between the check and the inoculated plants. This was evidently due to the presence of the wilt organism in the field and the infection of the plants after transplanting.

One field observation was made which is worthy of mentioning in connection with these studies. In 1919, Roscoe Bateman, of Grenloch, N. J., suffered considerable loss from eggplant wilt. In 1920 he planted on "new" land where eggplants had not been grown for many years, if ever. The major part of this new field was manured with manure purchased from the city market but a narrow strip received manure produced on the home farm. The plants grown on the area receiving city manure bore a fine crop of fruit and showed only a very small percentage of wilt, and that late in the season. The plants grown on the area receiving the home-made manure, on the other hand, failed to make a good growth and produced practically no marketable fruits. All these plants were affected by the wilt disease as was shown by the dwarfed condition, the darkening of the vascular tissue and the premature dying of the old leaves.

It seems evident that in this case the disease was carried in the manure. Although such observational evidence is not convincing, yet it should be taken as a caution against using manures which are liable to contain the wilt organism.

A test was made to determine whether or not seed taken from the fruit of wilted plants carries the wilt organism. Two ripe fruits were collected from plants which by external symptoms and by microscopic and cultural tests proved to be badly affected with *Verticillium* wilt. These fruits were surface-sterilized and cut open with a sterile knife. Five seeds from each of the fruits were plucked out with sterile forceps and placed into flasks containing nutrient agar, one seed being placed in each flask. Five other seeds were taken from each of the fruits and cut into halves and put into flasks of agar. These twenty cultures were incubated for 30 days at 29°C. Three of the flasks developed bacterial contamination but no fungus developed in any of the cultures. This test would indicate that the wilt organism does not advance into the seed of fruits borne on badly diseased vines.

Attempts to infect tomato and pepper plants with the *Verticillium* taken from wilted eggplants gave negative results.

SPRAYING EXPERIMENT FOR THE CONTROL OF PEAR FRUIT AND LEAF SPOT

C. M. HAENSELER

A spraying experiment was conducted in the spring of 1920 in a pear orchard owned by the Minch Bros., Bridgeton, N. J., to determine the relative efficiency of various spray mixtures in controlling the pear fruit and leaf spot caused by *Fabræa maculata*. The orchard was blocked off into five plots of about 30 to 40 trees each, and the plots sprayed as follows:

Plot 1. Check—no spray.
Plot 2. Commercial concentrated lime-sulfur; 1 gallon to 40 gallons of water.
Plot 3. Bordeaux mixture, 3-4-50.
Plot 4. Self-boiled lime-sulfur, 8-8-50.
Plot 5. Pyrox.

Three pounds of dry arsenate of lead per 100 gallons of spray was added to each of the mixtures except the Pyrox. Four spray applications were made; on May 17, May 27, June 9 and July 30, respectively.

During the summer the unsprayed plot developed considerable fruit and leaf spot and an examination made on September 22 showed that many of the unsprayed trees had lost one-half or more of their leaves as a result of the disease.

The commercial lime-sulfur, Bordeaux mixture, and Pyrox all gave a complete control of the fruit and leaf spot, but these mixtures caused more or less spray injury to the pear fruit. Although this spray injury did not affect the yield it was sufficient to mar the general appearance and consequently decrease the market value of the fruit.

On the self-boiled lime-sulfur plot a small amount of disease developed but the attack was not severe enough to cause any appreciable damage. The fruit on this plot did not show any signs of spray injury and was much smoother and better in general appearance than that from any of the other plots. Since the self-boiled lime-sulfur gave a practical control of the disease, and at the same time left the fruit in such perfect market condition, it may be concluded that the self-boiled lime-sulfur gave slightly better results in this experiment than did the other three spray mixtures.

This experiment was planned to compare the relative value of various spray mixtures in controlling the pear fruit and leaf spot and not to work out a complete spray calendar for this disease. The number of applications necessary to insure a complete control and the best time to apply these is still a problem to be solved, and will be taken up during the coming year.

Until a complete spray schedule has been experimentally worked out it will doubtless be best to use a schedule similar to that used so successfully in the above tests. From these tests we know that good results may be expected from four applications of self-boiled lime-sulfur, beginning about 10 days after petal fall, giving the first three sprays at 10 to 14-day intervals and the fourth spray about 3 weeks after the third. This treatment should give clean, smooth fruit and leave the trees in a vigorous condition to produce strong healthy fruiting spurs for the following year's crop.

PLATE 1

FIG. 1. BLACK ROT, A BACTERIAL DISEASE OF CABBAGE. NOTE DARKENING OF VEINS DUE TO ATTACK OF ORGANISM. *Bacterium campestris.*

FIG. 2. BACTERIAL SOFT ROT OF CARROT, DUE TO *Bacillus carotovurs* Jones.

PLATE 2

FIG. 1. LEAF SCORCH OF MAPLE.

FIG. 2. BUD ROT OF ROSES. *Botrytis* sp.

PLATE 3

FIG. 1. THE STREAK DISEASE OF TOMATO.

FIG. 2. LEAF MOLD OF TOMATO. *Cladosporium fulvum.*

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FOLIAGE INJURIES

MEL. T. COOK

During the spring and early summer of 1921 we had an exceptionally large number of inquiries concerning the scalding and falling of the foliage of trees. Most of these inquiries were concerning the foliage of sugar maple, Norway maple and beech, but some inquiries were made in regard to apple and cherry.

In this connection we must again call attention to warm weather in the early spring followed by frosts which destroyed the greater part of the peach and cherry crop and very greatly reduced the apple crop. The frost came when the young foliage was very susceptible to injury and the effects were noticeable on forest, shade and fruit trees. Furthermore, many leaves that did not show injury at that time fell in great abundance later in the season. This was very frequently confused with falling due to other causes. The greatest confusion was in regard to the cherry in which the falling was partly due to the early frost and partly to the leaf spot fungus *Cylindrosporium padi*.

The leaf-scald of the shade trees was due primarily to the lack of both water and food. City drainage is planned to get rid of the water as rapidly as possible, which makes it impossible for any considerable amount to penetrate the soil. Furthermore, the soil surface is reduced by the pavements. Since trees cannot get the mineral foods of the soil without water, they suffer for want of both water and food. The transpiration is increased by the reflected heat from the pavements and buildings. The result is the scalding or the falling of the foliage, and in some cases both.

This can be controlled to some extent by pruning out 25 per cent or more of the branches in the fall, by giving good applications of fertilizers in the spring and by loosening the soil around the trees so as to permit the water to enter the soil.

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